# JOURNAL OF GERONTOLOGY

VOLUME 13, NUMBER 4
OCTOBER, 1958

## Section A

## Biological Sciences and Clinical Medicine

JOURNAL OF GERONTOLOGY

VOLUME 13, SECTION A OCTOBER, 1958 NUMBER 4

# THE LONGEVITY AND MORTALITY OF THOROUGHBRED MARES*

A. COMFORT, Ph.D.

*(From the Department of Zoology, University College, London)*

In making comparative studies of the rate of aging in vertebrates it has proved extremely difficult to obtain reliable life tables for any large mammal other than man. Some data have been collected for dogs (4) and for animals in zoological gardens (5), but the series were small, statistically unsatisfactory, and subject to such high death rates that the survival curves, especially of zoo animals, were arithmetic straight lines. Records of agricultural stock have also been examined, but these rarely cover the whole potential life and are nearly always based on heavily-culled populations. Apart from isolated studies of wild and domestic sheep (13, 18), the available actuarial data for mammals are confined to man and small rodents.

The General Stud Book records the year of foaling, and in many cases the year of death or disposal, of the thoroughbred racehorses foaled in Britain since the end of the eighteenth century. This record has been compiled with careful attention to identity, and is greatly superior in quality and quantity to the other non-human mammalian vital statistics so far examined. The possibility of using it as a source of biological data has been realized before (24) but never fully exploited. For the purposes of most investigations each life-history must be individually extracted, and statistical treatment of a large sample is therefore extremely laborious.

This paper reports the analysis of two medium-sized samples undertaken to see how far the Stud Book could be expected to yield useful material for studies on the rate and comparative biology of mammalian aging, especially in relation to parental age effects and the inheritance of longevity. Study of parental age effects on the life span of man is complicated by the high correlation between ages of spouses (23); there is no such correlation between ages of sire and dam in horse-breeding, and both mares and stallions commonly remain at stud to advanced ages. One object of the study was to examine the claims of Vitt (24) that the Stud Book records indicate a large parental age effect on the vigor and longevity of thoroughbreds. Another was to see whether the records could be used to determine the extent of the parent-offspring and sib-sib correlations for life spans.

Survival curves based on Stud Book material were drawn for 2742 thoroughbred mares, foaled in the two periods 1875-1880 and 1860-1864, by annual cohorts; for 183 Arabian brood mares foaled in 1880 and the 35 following years; and for the lifelong progeny of 3 selected stallions. The data have also been scored and grouped by parental age, parental longevity, coat color, and in some cases longevity of progeny. About 5,000 life histories were extracted in all. The results are presented here. Some reservations on the usefulness of the record for the purposes attempted have become evident in the course of the study.

## MATERIAL AND METHOD

The Stud Book consists to date of 46 volumes, published at 4-year intervals since 1808. It is essentially a nominal list of brood mares, giving details of the serving, foaling, and ownership of each since the last entry. Arabian mares are listed separately.

From this record can be obtained (a) the year of birth of every thoroughbred foal under the name of its dam, and (b) the life history

Submitted for publication March 3, 1958.

* This work was undertaken during the tenure of a research fellowship given by the Nuffield Foundation, and received a CIBA 1958 award.

Published on a grant from the Forest Park Foundation to the JOURNAL OF GERONTOLOGY.

of every filly which returns to stud as a brood mare, from her first covering by a thoroughbred stallion until death or disposal from the stud.

Life histories of 3,337 mares were extracted from this record by following each individual animal by name from its first appearance as a brood mare until its last. This sample includes (a) all the thoroughbred fillies foaled in Britain, excluding Ireland, in the years 1875-1880 (Sample A), and 1860-1864 (Sample B), which subsequently re-enter the record as brood mares, and (b) all the Arabian mares foaled in 1880 and the 35 subsequent years, a compact group of manageable size, where 58.2% of all fillies returned to stud. The original 6 annual cohorts of thoroughbreds (Sample A) were chosen so that their survival period avoided the World Wars. After this sample had been analyzed, Sample B was taken to obtain more data upon the relationship of longevity to parental age. Thoroughbred fillies re-entering the record as mares accounted for 26.8% of all fillies foaled in 1875-1880 and 33% of those foaled in 1860-1864; the modal age of re-entry was 4 years. Deaths before this age have been excluded; deaths during the next two years may be under-represented through omission of mares dying without live progeny after being served but before being separately entered, especially in the 1860, 1864, 1876, and 1880 cohorts, which immediately precede the appearance of a volume.

Each life history normally ends in an entry that the animal was shot, died, was exported, or was disposed of (put out of stud, sold, given away as barren). Some end in unexplained disappearance from the record or in "no further return." Each unaccounted absentee was sought by name in each volume to the end of a 32-year period from its year of foaling, and for 2 volumes thereafter to allow for corrections. Each mare in the original 6 thoroughbred cohorts was scored for age at death or disposal, nature of disposal, coat color, age of dam at foaling, age of sire at service, longevity of dam, and longevity of sire where this could be ascertained from the obituary lists of stallions. The longevity of the dam and, for selected groups, the longevity of all the subject's female progeny, were determined by individual search, using the same system. Mares in Sample B (1860-1864) were scored for parental age alone.

The forms used in the terminal entries are "died," "shot," "sold," "sent abroad," and qualifications of these, e.g., "broke leg and shot," "died after foaling." The entries therefore discriminate between losses to the record, deaths due to accident, animals destroyed, and deaths presumed to be due to natural causes; but of animals entered as "died" only those dying at or after foaling, and of animals shot only those which met with an accident are usually distinguished. Deaths not attributed to accident or shooting account for 1009 out of the total 2742 lives in the cohort samples. Only these, which include deaths at or after foaling, were scored as "natural" in computing the age-dependent mortality, all other losses, and all animals dying at imprecise ages, being scored as lost to the record. Where the last surviving individual is lost to the record, it is assumed to have died in that year.

Life tables were then prepared by calculating the yearly mortality under this convention, with the usual correction for losses. The origin of all tables was taken at 4 years.

If $n_x$ is the number of animals known to be alive at x years of age, $d_x$ the number dying from conventional "natural causes" and $a_x$ the number killed or lost to the record between x and x + 1, then $q_x$, the mortality for that interval, is given by

$$q_x = \frac{d_x}{n_x - \frac{1}{2}a_x}$$

The expected proportion of survivors at time x in a population subject only to the conventional mortality is given by the product

$$L_x = (1 - q_0)(1 - q_1)(1 - q_2)\ldots(1 - q_{x-1})$$

and the expectation of further life at x years ($e_x$) where the last animal dies in the interval r to r + 1 is the sum

$$e_x = \frac{L_0}{L_x}(\tfrac{1}{2}L_x + L_{x+1} + L_{x+2} \cdot \cdots + \tfrac{1}{2}L_r)$$

For its standard error we used the approximation of Irwin (9);

$$\sigma_e = \frac{1}{L_0}\left[\sum_{x=0}^{r-1} S_{x+1}^2 \cdot q_x/N_x p_x\right]^{\frac{1}{2}}$$

$$(N_x = n_x - \tfrac{1}{2}a_x;\ p_x = (1 - q_x);\ S_{x+1} = \sum_{x+1}^{x=r} L_x)$$

Mean expectations of life are given in the text ± their standard errors.

Deaths have been referred to the midpoint of each interval without a grouping correction. But since most foals are born early in the year, the distribution of ages is eccentric, and it might be nearer the truth to take

$$e_0 = \tfrac{3}{4}L_0 + L_1 + \ldots\ldots + \tfrac{1}{4}L_r$$

It should be noted that in stating ages of thoroughbreds all foals are traditionally taken to be born on the first day of the year; in making comparisons with other figures for horses this may have to be taken into consideration.

## RESULTS AND DISCUSSION

1. *General form of the survival curve.*—Survival curves drawn for the 2742 thoroughbred mares and the tabulated figures from which they are derived are given in figure 1 and tables a and b. The curves for samples A and B coincide closely: they are of typical Gompertzian form, with a high early survival and a steadily increasing force of mortality. The modal age of adult death is 22 years. The proportions are very like those of prosperous human survival curves: the time equivalence, obtained by fitting the median and second quartile to the U.S. Census curve for white males, 1941, beginning at the age of 10, is roughly x 3.2. The terminal part of the curve calculated from $q_x$ values at ages of 25 and over is, of course, largely arbitrary, and in the late intervals losses, many of them from age-dependent causes, equal or exceed deaths. The mean expectation of life of all 4-year-olds, based on these ungraduated data, is 17.17 years.

The survival curves of the separate cohorts are roughly similar, but there are considerable

TABLE 1a. LIFE TABLE FOR 1492 THOROUGHBRED MARES, FOALED 1875-1880.

| Year Interval | $d_x$ | $a_x$ | $q_x$ | $L_x$ | D n x (10,000) | $e_x$ |
|---|---|---|---|---|---|---|
| 4– | 4 | 11 | 0.0027 | 1.0000 | 27 | 17.043 |
| 5– | 7 | 49 | 0048 | 9973 | 48 | 16.08 |
| 6– | 11 | 48 | 0079 | 9925 | 78 | 15.16 |
| 7– | 16 | 56 | 0120 | 9847 | 118 | 14.28 |
| 8– | 20 | 69 | 0159 | 9729 | 155 | 13.44 |
| 9– | 15 | 48 | 0127 | 9574 | 122 | 12.66 |
| 10– | 18 | 50 | 0162 | 9452 | 153 | 11.82 |
| 11– | 17 | 45 | 0162 | 9299 | 151 | 11.00 |
| 12– | 19 | 42 | 0194 | 9148 | 178 | 10.18 |
| 13– | 22 | 35 | 0237 | 8970 | 213 | 9.36 |
| 14– | 23 | 43 | 0265 | 8757 | 233 | 8.58 |
| 15– | 36 | 40 | 0448 | 8524 | 382 | 7.80 |
| 16– | 33 | 37 | 0452 | 8142 | 369 | 7.15 |
| 17– | 37 | 34 | 0560 | 7773 | 436 | 6.46 |
| 18– | 41 | 41 | 0699 | 7337 | 513 | 5.81 |
| 19– | 32 | 49 | 0639 | 6824 | 436 | 5.22 |
| 20– | 31 | 52 | 0742 | 6388 | 474 | 4.54 |
| 21– | 40 | 40 | 1173 | 5914 | 694 | 3.85 |
| 22– | 61 | 38 | 2328 | 5220 | 1216 | 3.30 |
| 23– | 34 | 33 | 2054 | 4004 | 822 | 3.15 |
| 24– | 24 | 25 | 2342 | 3182 | 744 | 2.83 |
| 25– | 12 | 24 | 2222 | 2438 | 542 | 2.54 |
| 26– | 10 | 11 | 4082 | 1896 | 774 | — |
| 27– | 2 | 2 | 2500 | 1122 | 280 | — |
| 28– | — | 1 | 0.0 | 0842 | 0 | — |
| 29– | 1 | 1 | 2857 | 0842 | 241 | — |
| 30– | — | 2 | (1.0) | 0601 | 601 | — |
| 31– | — | — | — | 0.0 | — | — |
| n= | 566 | 926 | — | — | 10,000 | — |
| | | | | | | $V_e$ =0.046 |
| | | | | | | $\sigma_e$ =0.214 |
| | | | | | | Standard deviation = 5.5 years |

TABLE 1b. LIFE TABLE FOR 1250 THOROUGHBRED MARES, FOALED 1860-1864.

| Year Interval | $d_x$ | $a_x$ | $q_x$ | $L_x$ | d n x (10,000) | $e_x$ |
|---|---|---|---|---|---|---|
| 4– | — | 1 | 0.0 | 1.0000 | — | 17.314 |
| 5– | 3 | 15 | 0024 | 1.0000 | 24 | 16.31 |
| 6– | 4 | 30 | 0033 | 9976 | 33 | 15.36 |
| 7– | 11 | 55 | 0094 | 9943 | 93 | 14.31 |
| 8– | 16 | 48 | 0145 | 9850 | 143 | 13.53 |
| 9– | 14 | 80 | 0136 | 9707 | 122 | 12.72 |
| 10– | 16 | 59 | 0170 | 9585 | 163 | 11.90 |
| 11– | 18 | 45 | 0206 | 9422 | 194 | 11.08 |
| 12– | 8 | 50 | 0099 | 9228 | 91 | 10.29 |
| 13– | 23 | 37 | 0303 | 9137 | 277 | 9.38 |
| 14– | 25 | 41 | 0359 | 8860 | 318 | 8.68 |
| 15– | 23 | 25 | 0360 | 8542 | 308 | 7.98 |
| 16– | 29 | 30 | 0493 | 8234 | 406 | 7.26 |
| 17– | 25 | 31 | 0473 | 7828 | 370 | 6.60 |
| 18– | 33 | 41 | 0706 | 7458 | 527 | 5.91 |
| 19– | 32 | 36 | 0808 | 6931 | 560 | 5.32 |
| 20– | 30 | 33 | 0910 | 6371 | 580 | 4.76 |
| 21– | 33 | 38 | 1250 | 5791 | 724 | 4.18 |
| 22– | 35 | 31 | 1718 | 5067 | 902 | 3.69 |
| 23– | 19 | 22 | 1407 | 4165 | 586 | 3.39 |
| 24– | 22 | 24 | 2366 | 3579 | 847 | 2.88 |
| 25– | 15 | 18 | 3000 | 2732 | 820 | 2.60 |
| 26– | 6 | 9 | 2791 | 1912 | 534 | — |
| 27– | 1 | 5 | 1176 | 1378 | 162 | — |
| 28– | 1 | 1 | 2222 | 1216 | 270 | — |
| 29– | 1 | 1 | 4000 | 0946 | 378 | — |
| 30– | — | 1 | 1.0 | — | 568 | — |
| n= | 443 | 807 | — | — | 10,000 | — |
| | | | | | | $V_e$ =0.044 |
| | | | | | | $\sigma_e$ =0.214 |
| | | | | | | Median: 22.07 years |

differences in performance between them (tables 2, 3), the last 3 years of the 1875-1880 sample having a shorter expectation of life than any of the others ($0.05>p>0.02$ for the largest difference). The proportion of scoreable lives to total fillies foaled is rather higher in sample B (33.0 against 26.8%) but there is no immediately obvious reason for the differences in cohort performance. There is, however, almost certainly a bias in sampling, since the two lowest scoring cohorts of sample A contain an unusually low proportion of late entrants to the record. Mares are normally entered when first covered, but animals among the unaccounted majority which have not been regularly at stud may enter the record at any age if they produce a thoroughbred foal. The number of these late entrants varies from cohort to cohort, and lives included in this way are subject to a bias in favor of the eventual inclusion of animals which survive and omission of those which die or remain barren. Some histories of dead animals may appear retrospectively, but this is only likely to occur if they have at least one thoroughbred foal which lives. Late entrants are most numerous in the first two, and fewest in the last two, cohorts of Sample A, and the early mortality is likely to be correspondingly

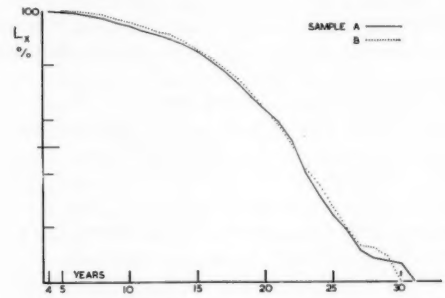


Fig. 1. Survival curves of thoroughbred mares foaled in 1875-80 (Sample A) and 1860-64 (Sample B).

TABLE 2. LONGEVITY OF THOROUGHBRED MARES BY YEARS OF BIRTH.

| Year | Number Scored | Total Year's Fillies | % | (Years) $e_{x=4}$ | $V_e$ | Median |
|---|---|---|---|---|---|---|
| 1860 | 242 | 726 | 33.33 | 17.44 | 0.21 | 22.70 |
| 1861 | 255 | 763 | 33.42 | 17.28 | 0.18 | 21.86 |
| 1862 | 244 | 757 | 32.23 | 17.33 | 0.35 | 21.82 |
| 1863 | 241 | 783 | 30.78 | 16.58 | 0.21 | 21.62 |
| 1864 | 268 | 756 | 35.45 | 17.39 | 0.17 | 22.03 |
| 1860–1864 | 1250 | 3785 | 33.03 | 17.31 | 0.044 | 22.07 |
| 1875 | 285 | 910 | 31.32 | 17.26 | 0.34 | 22.43 |
| 1876 | 245 | 863 | 28.39 | 17.64 | 0.21 | 22.43 |
| 1877 | 233 | 915 | 25.46 | 17.44 | 0.21 | 22.49 |
| 1878 | 248 | 969 | 25.59 | 17.49 | 0.30 | 22.15 |
| 1879 | 261 | 952 | 27.42 | 16.13 | 0.16 | 20.81 |
| 1880 | 221 | 954 | 23.17 | 16.01 | 0.18 | 21.81 |
| 1875–1880 | 1492 | 5565 | 26.82 | 17.04 | 0.046 | 22.18 |
| Arabians 1880–1915 | 183 | 314 | 58.26 | 18.81 | 0.43 | 23.66 |

TABLE 3. LONGEVITY OF THOROUGHBRED MARES BY PARENTAL AGES (SIRE AT COVERING, DAM AT FOALING).

| | | n | (Years) $e_{x=4}$ | $V_e$ | Median |
|---|---|---|---|---|---|
| **Mares foaled 1875–80 (Sample A) and 1860–64 (Sample B).** | | | | | |
| Dam: Sample A) under 8 years | | 297 | 16.90 | 0.12 | 21.07 |
| 8–12 | | 537 | 16.66 | 0.09 | 21.06 |
| 13–16 | | 303 | 17.29 | 0.17 | 22.21 |
| >17 | | 248 | 16.15 | 0.23 | 22.83 |
| Sire: (Sample A) under 8 years | | 250 | 16.73 | 0.16 | 22.10 |
| 8–12 | | 537 | 17.11 | 0.10 | 22.35 |
| 13–16 | | 352 | 17.26 | 0.20 | 21.83 |
| 17–19 | | 151 | 16.87 | 0.28 | 22.08 |
| >20 | | 65 | 16.87 | 0.73 | 21.03 |
| Dam and Sire: < 9 years | Sample A | 128 | 17.91 | 0.22 | 22.28 |
| | B | 220 | 16.51 | 0.27 | 21.50 |
| <12 | A | 449 | 17.39 | 0.22 | 22.28 |
| | B | 531 | 17.07 | 0.11 | 21.90 |
| | A+B | 980 | 17.33 | 0.07 | 22.10 |
| >13 | A | 270 | 16.45 | 0.23 | 21.61 |
| | B | 150 | 17.24 | 0.28 | 22.64 |
| | A+B | 420 | 17.03 | 0.16 | 22.05 |
| >16 | A | 70 | 15.71 | 0.69 | 20.41 |
| | B | 44 | 17.26 | 1.10 | 23.17 |
| **Progeny of Hermit, Galopin and Hampton** | | | | | |
| All mares | | 412 | 16.60 | 0.15 | 21.73 |
| Got in or after sire's 20th year | | 124 | 16.65 | 0.33 | 21.83 |
| Got in or after sire's 16th year, dam >16 at foaling | | 41 | 16.29 | 0.89 | 21.19 |
| **All mares (A, B and selected sires)** | | | | | |
| by parents >16 years | | 154 | 16.45 | 0.38 | 21.12 |

affected. On the basis of mortality rates calculated for mares entered in all the cohorts at 4 years of age, omitting subsequent entrants, it seems that this bias is enough to account for some, although not all, of the differences observed.

The mean expectation of life of Arabians was significantly higher than that for any cohort of thoroughbreds ($e_{x=4} = 18.81 \pm 0.66$ years) and the rate of decline slower.

2. *Maximum age records.*—The highest ages in the series were reached by Arabians, 3 mares reaching 31 years, and one dying in its 33rd year (born 1911, died 1943; last covered, but barren, 1942): these ages may only indicate more conscientious returns for Arabians past breeding age, compared with thoroughbreds. The two oldest thoroughbred mares in the sample were alive at 30 years. The Stud Book has not been searched in detail for higher records—the oldest mare so far encountered (Blue Bell, by Heron out of Jessie) was foaled in 1851 and died in 1885 at the age of 34. Pocahontas (Stockwell's, Rataplan's and King Tom's dam) was foaled in 1837, died in 1870, and bore her last foal in 1862. The frequency with which such ages are actually reached by thoroughbred mares is largely determined by human intervention, since many which disappeared from the record at ages of 25 or over were probably capable of living longer—some no doubt did so, but extreme ages of mares put out of stud are not usually recorded. The stallion Matchem (1749-1781) reached a reputed age of 33: in the obituary lists of the Stud Book one other stallion reached 32, and 4 reached 31.

These ages are congruent with maximum authenticated records in other breeds: Hokkaido ponies 32 + (14); Hafling mares, over 32 (22); Lipitsa horses ♂ 31, ♀ 33, (12). Claims of higher ages have been reviewed elsewhere (3). Many of these refer to ponies, and none is supported by Stud Book records. Thirty-eight years is recorded in a captive zebra (25).

3. *Effects of parental age on the longevity of progeny.*—Vitt (24) has claimed that the longevity and racing performance of thoroughbred horses are substantially influenced by the age of both dam and sire, and that impairment of vigor by the use of old breeding stock is cumulative. He found that in a sample of 100 mares from vol. 1 of the General Stud Book, the progeny of dams 12 years old or less developed more slowly, judged by the age at first foaling, and live longer ($e_{x=4} = 19.5$ years) than the progeny of dams aged 13 or more ($e_{x=4} = 16.4$ years). Absolute figures and standard errors are not cited, and it is not clear whether the estimates are corrected for losses or based on the distribution of recorded deaths alone. Vitt also compared the fertility and racing form of foals by old and young stallions, and concluded that there was an equally marked paternal age effect, the optimal performance being reached by the foals of stallions 8-16 years old out of mares 6-13 years old. These claims raise many biologically important issues: they are of particular gerontologic interest because of their similarity to the findings of Lansing (15) in rotifers.

The lives of mares making up the 6 cohorts of sample A were distributed (a) by age of dam at foaling, (b) by age of sire at covering, one year earlier, (c) by age of dam at foaling and sire at covering, where these fell in the same grouping interval. Of 1492 lives, 1342 were scored and grouped by age of dam, 1355 by age of sire, and 719 by both. The missing lives were those scored for one parent only, being chiefly the progeny of imported horses, of stallions whose dates of birth were not easily ascertainable from the record, or of mares covered by more than one stallion in the season. The distribution of parental ages is shown in figure 2, and the results of the calculation in table 3.

There was no significant difference in expectation of life between foals of mares under and over 13 years of age. ($< 12$, $e_{x=4} = 16.89$:

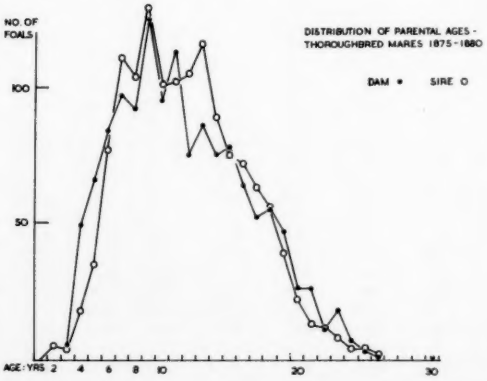


Fig 2. Ages of dams and sires contributing progeny to sample A (dam's age at foaling—sire's age at covering, one year earlier).

> 13, $e_{x=4}$ = 16.86 years). With further subdivision the progeny of the oldest mares had the shortest life spans, but the largest difference was less than twice its standard error. Still smaller differences were obtained for the same lives grouped by paternal age alone. Of the 719 lives grouped by age of both parents, those whose dam and sire were under 13 years old lived slightly longer (17.39 ± 0.36) than those whose parents were over 13 (16.45 ± 0.48; $t \neq 2.3$, $0.02 > p > 0.01$), and the difference was greater in the extreme segments of these groups (dam and sire <9, 17.91 ± 0.47; >16, 15.71 ± 0.83; $t \neq 2.3$, $0.02 > p > 0.01$). This difference is much smaller than that described by Vitt (24) from maternal age alone, and is of the order of the difference between cohorts.

In view of this result, the 5 additional cohorts (sample B) were extracted and scored for parental age, with the results shown in table 3. The differences found in the 1875-1880 sample were not repeated here. The longest-lived group were the progeny of parents of 16 years and over, but the standard error was very large (17.26 ± 1.09): the 220 animals which were the progeny of two young parents had numerically the shortest life spans (16.51 ± 0.52): none of the differences was significant, and all were in the reverse direction to those in the 1875-1880 sample.

We also calculated the mean expectations of life of the foals sired early and late in life by 3 selected stallions; Hermit, by Newminster (1864-1890), Galopin, by Vedette (1872-1899); and Hampton, by Lord Clifden (1872-1897), for comparison with Vitt's analysis of the progeny of Swynford. These 3 stallions produced in their lifetime 141, 119, and 159 fillies which returned to stud. Forty-six, 13, and 6 of these came from the cohorts already scored, the remaining 347 being new lives. The combined curve of survival for all Hermit, Galopin, and Hampton mares coincided closely with that for the original 6 cohorts; their mean expectation of life at 4 years was 16.50 ± 0.39 years. The 121 mares got during or after their sire's 20th year had a slightly, but not a significantly, higher expectation than the global mean (16.65 ± 0.57). Only 41 mares were got by the 3 selected stallions in or after their 16th year upon dams 16 years old or more; these had a mean expectation of life of 16.29 ± 0.94 years. By combining these mares with all the progeny in samples A and B of parents 16 years old or over, we obtained 154 lives, with $e_{x=4}$ = 16.45 ± 0.62 years, which is less than any of the 3 global means, but not significantly so. These results, taken as a whole, seem to afford no evidence of any consistent effect of parental age on the longevity of mares.

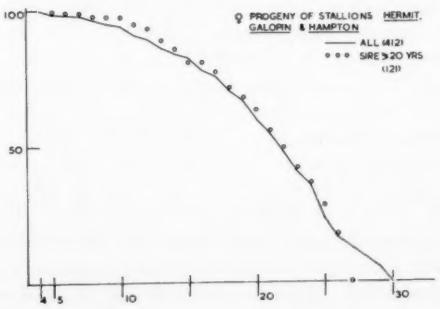


Fig. 3. Survival curves (a) of all fillies by the three stallions Hampton, Galopin and Hermit, and (b) of those fillies begotten in or after the sire's 20th year.

4. *Correlation between life spans of parents and offspring.*—Since age of death depends in part upon heritable factors, there should be a measurable difference in longevity between the foals of long-lived and short-lived parents, although Beeton and Pearson's results in man (2) suggest that it might not be large. All the mares in sample A were scored for the longevity of their dam, and as many as possible for the longevity of their sire: the data of death could be ascertained only for stallions whose names appeared in the obituary lists, or rather less than half the sires contributing to the sample. Life tables were made (a) for all the mares in sample A whose dams were known to have reached the age of 25, or died before the age of 14, (b) for mares in sample A whose sires reached age 25 or died before 15, and (c) for the female progeny of those mares in sample A which reached 25 or died before 14. To obtain a correlation with the ages reached by both parents, a life table was made for 113 mares in the sample whose dam and sire both reached 23 years. The inconsistency of the grouping limits in this case is due to the need to secure enough lives for the calculations; the relative contribution of short-lived mares to the sample was so small that it was not possible to prepare a table for the survival of their fillies by short-lived stallions. The series of mares by the 3 long-lived stallions, Hermit, Galopin, and Hampton was also grouped by longevity of dam.

TABLE 4. LONGEVITY OF THOROUGHBRED MARES BY LONGEVITY OF PARENTS.

| | (Years) | | | |
|---|---|---|---|---|
| | n | $e_{x=4}$ | $V_e$ | Median |
| **Mares foaled in 1875–80** | | | | |
| Sire reached 25 years* | 132 | 17.54 | 0.50 | 22.63 |
| Sire died < 14 | 113 | 16.27 | 0.60 | 22.53 |
| Dam reached 25 years | 238 | 16.96 | 0.16 | 22.25 |
| Dam died < 13 | 53 | 16.35 | 0.59 | 21.18 |
| Dam and sire reached 23 years | 113 | 18.07 | 0.34 | 23.74 |
| **Progeny of mares foaled in 1875–80** | | | | |
| Dam reached 25 years | 168 | 16.33 | 0.31 | 22.54 |
| Dam died < 13 | 58 | 16.67 | 1.25 | 20.02 |
| **Progeny of Hermit, Galopin and Hampton** | | | | |
| Dam reached 24 years | 100 | 17.11 | 0.82 | 21.52 |
| Dam died < 18 years | 58 | 15.39 | 0.83 | 21.51 |

* Stallions whose date of death appears in the obituary lists: mares by Hermit, Galopin, and Hampton are excluded from this figure, but included in the figure for dam and sire $\leqq$ 23 years.

The calculated means (table 4) show differences of less than twice the standard error in favor of all the groups with one long-lived parent, except the progeny of long-lived mares in the 1875-1880 sample: the 113 mares with two long-lived parents had a mean expectation of life at 4 years of $18.07 \pm 0.58$ years, which is significantly more than the global mean, or the mean for any other group. The true difference is moreover likely to be minimized, since nearly half the dams and more than half the sires contributing to the sample died at unknown ages or from accidental causes, and these losses must include some potentially or actually long-lived pairs. The difference in life span of fillies by the 3 selected stallions out of long- and short-lived dams was about 1.3 times its standard error, but the short-lived mothers contributed only 53 lives, even when the grouping limit was raised to 18 years, and the comparison means little.

In view of Vitt's opinions, we also made a table of the early progeny of long-lived parents, taking all the available mares from all the scored samples whose dam and sire were aged 15 or less at the time of foaling or conception, but lived eventually to an age of 23 or more. The performance of these mares was in fact numerically but not significantly poorer than that of the groups scored without regard to parental age ($e_{x=4} = 17.09 \pm 0.89$ years).

5. *Other correlations.*—The samples have not yet been analyzed by coat color. In Rhenish horses, Schiermann (21) found a correlation between color and longevity. There is a bias evident in Stud Book records, due to the selective export of grey, roan, and black horses; this tendency becomes very marked as the record progresses, and the number of lives in the original 6 cohorts of sample A is insufficient to compare the life span of these colors. The remaining colors (bay, brown, chestnut) are subject to some scoring errors when recorded at foaling, but are present in the proportions of about 1 : 1 : 0.1.

## CONCLUSIONS

The first and most evident conclusion is that while the initial sample of 1492 lives was enough for the preparation of a reasonably reliable mortality curve, it was inadequate for the other purposes in mind—chiefly because of the very small number of "natural" deaths available under the scoring convention adopted. The remaining lives contribute in varying degree to the statistical weight of the sample, but for satisfactory sub-grouping by maternal age, longevity, etc. it would be desirable to begin with at least 5 times the number of lives.

The supposed parental age effect on longevity is perhaps the most interesting gerontologic matter on which the Stud Book seemed likely to throw light. The literature of mammalian parental, and particularly paternal, effects on longevity is contradictory and is reviewed elsewhere (3, 17). Jalavisto (11) found a smallish effect in man. Yerushalmy (26) found an increased stillbirth rate with very old or very young fathers, but the difficulty arising from correlation between ages of spouses (23) affects the value of such data. Maternal age effects have been widely considered (17), but there seem to be interspecific differences in their influence on longevity. Paternal age effects on stock performance have been claimed, chiefly by the Russian school (1, 6, 7, 10, 19, 20, 27). We have examined only one specific effect, that on longevity; this might or might not be associated with other desirable traits in racehorses or farm stock. Man and the horse, since they commonly reach old age, are in any case the mammals in which the effect is most likely to be demonstrable.

The figures which we have obtained for performance in terms of longevity alone do not uphold Vitt's contentions, or give evidence of any consistent difference in life span between the progeny of young and old parents, even upon a sample which seems to be substantially larger than that which he analyzed; there was a formally significant deficiency in the expectation of life of foals obtained by crossing elderly parents in one sample only, and comparable groups differently obtained showed no such effect. Although the samples were small and the standard errors concerned are approximations, the effect, if real, is of enough biologic interest to demand a far more convincing demonstration. No such effect can be inferred from these two series.

It seems, on the evidence of the samples, unlikely that the Stud Book record can be used for effective studies of the influence of parental age over a succession of generations along the lines of Lansing's work on "orthoclones" (15), because of the enormous wastage, at each fresh subdivision, of lives where one or another piece of relevant information is lacking. Nor is it very suitable for studies on the duration of fertility, because barren mares are selectively culled.

The apparent smallness of the correlation between life-span of parent and offspring need not necessarily be due to the inadequacy of the material or the sampling. In man, the parent-child correlation of longevity was found (2) to be about one-eighth of that for stature, infant deaths excluded. The sib-sib correlation was considerably larger: this, as Haldane (8) suggests, might be expected if longevity depends upon being heterozygous for many factors rather than upon the inheritance of a few. The sib-sib correlation is difficult to obtain from the Stud Book data, partly, again, because of the number of lives which do not end in scoreable deaths and partly because repetitions of the same cross are relatively infrequent. The half-sib correlation should be obtainable by plotting mean longevity of progeny against longevity of sire for a number of productive stallions. Comparison of individual sires is needed in any case because of the small number contributing to some of the samples and the likelihood of bias if there is a large individual difference in the longevity of their progeny.

An adverse effect of high age in both parents, if it existed, would have evident implications for the selective advantages of longevity, but the single able for the early foals of long-lived parents does not suggest that the inheritance of long life is being masked in this way. The most striking feature, from the standpoint of selection, which appears from the whole study is the smallness of the contributions made by short-lived parents to the next generation. Since the scoring is based on deaths only, culling of barren animals played no part in this effect. The relative fertility of mares which died young has still to be computed, but it seems as if under stud breeding conditions there is, in effect, intensive selection for longevity. Murie's work on sheep (18) suggests that in some large animals the wild survival curve is not very different from that in domestication. If this were true of wild populations of horses, longevity of the dam, and probably, in the presence of competition between males, longevity of the sire, would have a large selective advantage; the upper limit of the life span would have in this case to be fixed by some mechanism other than the decline of selection pressure suggested by Medawar (16).

It seems that the Stud Book contains information capable of throwing light on at least 3 important gerontologic questions—the reality of supposed parental age effects, the comparative parent-offspring and sib-sib correlations of long and short life, and the long-term effects of selection for longevity and of partial inbreeding in a long-lived mammal. It has already given a serviceable measure of the time-scale of actuarial aging in two breeds. A life table for stallions, although rather more difficult to abstract, is also being prepared from the record. Most of the important information, including evidence of any secular changes in the longevity of thoroughbreds, could be obtained most readily by putting a large section of the records on punch cards for mechanical analysis. The possibility of doing this with a sample extending over 20 or more years is being considered; such an index would have a number of uses in gerontologic research.

## SUMMARY

Life tables and curves of survival from 4 years of age were prepared for 2742 thoroughbred mares, and for 183 Arabian mares, drawn from consecutive periods of the General Stud Book.

The mean expectation of life of Arabians was

significantly greater than that of thoroughbreds, and there were differences between the expectation of life of successive thoroughbred cohorts, the largest of which were significant.

Age of dam at foaling and age of sire at conception, scored independently, did not significantly affect the life expectation of mares from the age of 4. In one of the series examined the offspring of parents both 16 years old or more had a significantly shorter life expectation than the offspring of parents both under 10 years old. In a second series, the difference was in the reverse direction. No evidence of a consistent parental age effect on the longevity of mares was found.

The progeny of long-lived mares and of long-lived stallions had a greater expectation of life than the progeny of short-lived mares and stallions. Differences were not significant when each parent was scored independently but were significant for the progeny of two long-lived parents.

A life table was constructed for all mares by the stallions Hermit, Galopin, and Hampton. There was no significant difference between the expectations of life of mares sired by these stallions before and after their 20th year of life.

The use of the General Stud Book as a source of material for studies of the biological aspects of aging is discussed. A larger-scale study is projected.

## REFERENCES


1. Barton, R. A.: Is Age of Parents Important in Sheep? *Nature, London, 168:* 37, 1951.
2. Beeton, M., and Pearson, K.: On the Inheritance of the Duration of Life, and on the Intensity of Natural Selection in Man. *Biometrika, 1:* 55-89, 1901.
3. Comfort, A.: *The Biology of Senescence.* Routledge, London, 1956.
4. Comfort, A.: Longevity and Mortality of Irish Wolfhounds. *Proc. Zool. Soc. London, 127:* 27-34, 1956.
5. Comfort, A.: Survival Curves of Mammals in Captivity. *Proc. Zool. Soc. London, 128:* 349-364, 1957.
6. Eidrigevits, E. V., and Polyakov, E. V.: (The Influence of Parental Age on Progeny Quality in Cattle of the Alatau Breed.) *J. Gen. Biol., Moscow, 14:* 435-440, 1953.
7. Frankland, H. M. T.: The Influence of Age of Sire on Quality of Progeny of Swaledale Sheep. *J. Agric. Sci., 46:* 180-182, 1955.
8. Haldane, J. B. S.: Paternal and Fraternal Correlations of Fitness. *Ann. Genet., 14:* 288-292, 1959.
9. Irwin, J. O.: The Standard Error of an Estimation of Expectation of Life, with Special Reference to Expectation of Tumourless Life in Experimental Mice. *J. Hyg., 47:* 188-189, 1949.
10. Isupov, A. P.: (Influence of Age of Stallion on the Quality of Progeny.) *Konevodstvo, 4:* 29-32, 1949.
11. Jalavisto, E.: The Influence of Parental Age on the Expectation of Life. *Rev. méd. Liège, 5:* 719-722, 1950.
12. Kadic, M.: Prilog poznavanju trajanja zivota konja. *Jugoslav. vet. Glasn., 2:* 602-603, 1949.
13. Kelley, R. B.: Female Aspects of Relative Fertility in Sheep. *Australian Vet. J., 15:* 184-194, 1939.
14. Matsumoto, K.: Das Hokkaido-Pony und seine Messung. *Ztschr. Gestütk. Pferdez., 30:* 127-130, 165-169, 1935.
15. Lansing, A. I.: A Transmissible, Cumulative, and Reversible Factor in Aging. *J. Gerontol., 2:* 228-239, 1947.
16. Medawar, P. B.: *An Unsolved Problem of Biology.* H. K. Lewis, London, 1952.
17. Miner, R. W. (ed.): Parental Age and Characteristics of Offspring. *Ann. N. Y. Acad. Sci., 57:* 451-614, 1954.
18. Murie, A.: *The Wolves of Mt. McKinley.* Dept. Int. Nat. Parks Service, Washington, 1944.
19. Ponomareva, L. I., and Spitskaya, T. D.: (Influence of Age-Selection on the Progeny of Young Horses.) *Konevodstvo, 23:* 28-32, 1953.
20. Pospelov, S. P.: (Importance of Age-Scoring in Stud Practice.) *J. Gen. Biol., Moscow, 13:* 445-454, 1952.
21. Schiermann, E.: Untersuchungen ueber die Lebensdauer und Fruchtbarkeit des rheinisch-deutschen Kaltblutpferdes. *Arb. dtsch. Tierz.,* Bonn., *20:* 1948.
22. Schotterer, A.: Alters- und Fruchtbarkeitsrekorde der Haflingstuten, "Venus" und "Leda." *Dtsch. landw. Tierz., 43:* 228-229, 1939.
23. Sonneborn, T. M.: *Proc. A. I. B. S. Conference,* Gatlinburg, Tenn., U. S. A., 1957 (in press).
24. Vitt. V. O.: On the Theory of Age-Selection in Stock: I. Influence of the Age of Stock on the Inherited Qualities of Their Progeny. *J. Gen. Biol., Moscow, 10:* 161-179, 1949.
25. Weber, R.: Hohes Alter verschiedener Tiere im Düsseldorfer Zoologischen Garten. *Zool. Gart., 14:* 208, 1942.
26. Yerushalmy, J.: Age of Father and Survival of Offspring. *Human Biol., 11:* 342-356, 1939.
27. Zamyatin, N., Stolbova, A., Chugaeva, M., and Kuznetsova, G.: Age of Parents and Quality of Progeny. *Trud. Novosibirsk selskh. Inst.,* 7: 107-117, 1946.

# SENESCENCE AND THE METABOLISM OF VARIOUS TISSUES OF RATS*

C. H. BARROWS, JR., Sc.D., M. J. YIENGST, B.S, AND N. W. SHOCK, Ph.D.
*(From the Gerontology Branch, National Heart Institute, National Institutes of Health, PHS, D.H.E. & W., Bethesda, and the Baltimore City Hospitals, Baltimore)*

Decrements observed in the physiological functions of tissues with increasing age may be a consequence of either a loss of cells from the tissues, a reduced metabolic activity of the individual cells, or a combination of both. Therefore it is desirable to have some index of the number of cells present in samples examined for age-dependent changes in tissue metabolism.

In these studies the endogenous oxygen uptake of liver and kidney slices and the anaerobic glycolysis of liver slices were determined to estimate the over-all metabolism in the tissues of rats of different ages. Although data obtained from these measurements may indicate the effect of aging on over-all metabolic systems, changes in the concentrations of specific enzymes may escape detection. Since available energy is required for the maintenance of cellular function, enzymes within the Krebs Citric Acid Cycle were determined. In this first series of experiments the concentration of succinoxidase in homogenates prepared from liver, kidney cortex, and heart of young and old rats was measured. Analyses of homogenates prepared from kidney cortex were also carried out for the activities of succinic dehydrogenase and cytochrome c oxidase. The concentration of desoxyribose nucleic acid in homogenates prepared from the various tissues served as an index of the number of cells in the samples. Protein nitrogen was also determined since it has been used frequently as a basis for metabolic activities.

The present study was designed to investigate changes in tissue metabolism with age and to determine the extent to which these changes may be attributed to cellular loss.

## MATERIALS AND METHODS

*Animals.* All rats used in these studies were of the McCollum strain and were bred and maintained in our animal quarters. They were housed, 5 in a cage, on wood shavings in a room maintained at 75 ± 2 F. A standard stock diet (1) was fed *ad libitum*. All animals were unmated. In each experiment the various determinations were carried out on the tissues of 10 males and 10 females, aged 12-14 months, and the same number of 24-27-month-old animals.

*Preparation of Tissue Samples.* Following decapitation of the animals, the organs were removed and placed in a moist Petri dish which was surrounded by cracked ice. Liver slices approximately 0.50 mm. and slices of kidney cortex 0.35 mm. thick were prepared with a Stadie Riggs microtome. A specially machined plastic head was used to obtain the thinner kidney slices. The slices were weighed on a Roller Smith torsion balance. Distilled water homogenates were prepared in a teflon tissue grinder immersed in an ice bath.

*Endogenous Oxygen Uptake.* A single liver slice weighing between 65.0 and 85.0 mg. was introduced into a Warburg flask. Two slices of kidney were often necessary to insure a tissue sample weighing from 45.0 to 65.0 mg. The main compartment of the Warburg flasks contained 3.0 $cm.^3$ of Krebs' phosphate buffer, and the center well 0.2 $cm.^3$ of 10% KOH. Following a 10-minute period of flushing with oxygen, the system was allowed to equilibrate 5 minutes at 37.0 C. Readings were then taken every 15 minutes for 45 minutes during which period the rate of oxygen uptake was constant.

*Anaerobic Glycolysis.* Two liver slices whose total weight ranged from 135.0 to 165.0 mg. were transferred to a Warburg flask containing 3.0 $cm.^3$ of Krebs bicarbonate buffer. The flasks were flushed for 10 minutes with a mixture of 95% nitrogen and 5% carbon dioxide and allowed to equilibrate 5 minutes at 37.0 C. The carbon dioxide evolved was measured during the next two 10-minute intervals and found to be constant during this period.

*Enzymes.* Determinations of all enzymic activities were carried out at two concentrations of tissue and for two time periods.. The rates of the enzymic activities were directly proportional to the amount of tissue assayed and were constant with time.

* Submitted for publication August 15, 1958. A preliminary report of this work appeared in Federation Proceedings, *16:* Part I, 7-8, March 1957.
The technical assistance of Miss Lois M. Roeder is gratefully acknowledged.

TABLE 1. THE EFFECT OF AGE ON RESPIRATION AND SPECIFIC ENZYMES OF THE KIDNEY OF THE RAT.

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | Young | Old | $P_{diff.}$ | $\frac{\text{Young-Old}}{\text{Young}} \times 100$ | Young | Old | $P_{diff.}$ | $\frac{\text{Young-Old}}{\text{Young}} \times 100$ |
| **Experiment 1** | | | | | | | | |
| N | 10 | 10 | | | 10 | 10 | | |
| Endogenous Oxygen Uptake ($mm.^3O_2$/100 mg. wet wt./hr.) | 378 ± 7* | 344 ± 10 | .01 | 11 | 368 ± 10 | 344 ± 4 | .05 | 6 |
| Desoxyribose Nucleic Acid (μg./100 mg. wet wt.) | 395 ± 6 | 366 ± 6 | .01 | 8 | 362 ± 7 | 358 ± 6 | NS | 1 |
| Succinoxidase ($mm.^3O_2$/100 mg. wet wt./hr.) | 3000 ± 136 | 2472 ± 140 | .01 | 18 | 2856 ± 176 | 2684 ± 132 | NS | 6 |
| Succinic Dehydrogenase (μg. TTC†/reduced/100 mg. wet wt./hr.) | 375 ± 15 | 300 ± 12 | .01 | 20 | 357 ± 14 | 357 ± 10 | NS | 0 |
| Protein N (mg./100 mg. wet wt.) | 2.68 ± .03 | 2.55 ± .04 | .01 | 5 | 2.80 ± .05 | 2.66 ± .04 | .05 | 5 |
| **Experiment 2** | | | | | | | | |
| N | 8 | 8 | | | 7 | 8 | | |
| Cytochrome c oxidase ($mm.^3O_2$/100 mg. wet wt./hr.) | 10,500 ± 255 | 9440 ± 405 | .05 | 10 | 10,050 ± 308 | 8900 ± 695 | NS | 11 |
| Desoxyribose Nucleic Acid (μg./100 mg. wet wt.) | 383 ± 13 | 397 ± 11 | NS | −4 | 365 ± 16 | 360 ± 12 | NS | 1 |

* Mean and standard deviation of the mean.
† Triphenyltetrazolium chloride.

The succinoxidase activity of 5% homogenates of liver, kidney cortex, and heart was determined by the method of Schneider and Potter (8). The succinic dehydrogenase activity of 10% homogenates prepared from kidney cortex was determined by the method of Kun and Abood (6). The cytochrome c oxidase activity of 1% homogenates of kidney cortex was determined by the method of Schneider and Potter (8).

*Protein Nitrogen.* The nitrogen content of the 7% cold trichloroacetic acid insoluble material of the various homogenates was determined by the micro-Kjeldahl procedure of Hiller, Plazin, and Van Slyke (4).

*Desoxyribose Nucleic Acid.* Samples for the measurement of desoxyribose nucleic acid were prepared by the method of Schneider (9); and the desoxyribose nucleic acid determined by the method of Stumpf (12).

## RESULTS

*Kidney—Females.* The rates of endogenous oxygen uptake of kidney cortex slices of old rats were significantly decreased, 11% per unit of wet weight (table 1—experiment 1). This de-

TABLE 2. THE EFFECT OF AGE ON SUCCINOXIDASE ACTIVITY OF HEART MUSCLE OF THE RAT.

| | N | Succinoxidase ($mm.^3O_2$/100 mg. wet wt./hr.) | Desoxyribose Nucleic Acid (μg./100 mg. wet wt.) | Protein N (mg./100 mg. wet wt.) |
|---|---|---|---|---|
| **Females** | | | | |
| Young | 10 | 4572 ± 144* | 112 ± 3 | 2.95 ± .05 |
| Old | 10 | 4188 ± 120 | 108 ± 3 | 2.86 ± .09 |
| $P_{diff.}$ | | .05 | NS | NS |
| $\frac{\text{Young-Old}}{\text{Young}} \times 100$ | | 9 | 3 | 3 |
| **Males** | | | | |
| Young | 10 | 4384 ± 116 | 106 ± 4 | 2.85 ± .06 |
| Old | 10 | 4008 ± 104 | 106 ± 3 | 2.76 ± .02 |
| $P_{diff.}$ | | .05 | NS | NS |
| $\frac{\text{Young-Old}}{\text{Young}} \times 100$ | | 9 | 0 | 3 |

* Mean and standard deviation of the mean.

TABLE 3. THE EFFECT OF AGE ON RESPIRATION, ANAEROBIC GLYCOLYSIS, AND SUCCINOXIDASE OF THE LIVER OF THE RAT.

| | N | Anaerobic Glycolysis (mm.$^3CO_2$/100 mg. wet wt./hr.) | Endogenous $O_2$ Uptake (mm.$^3O_2$/100 mg. wet wt./hr.) | Desoxyribose Nucleic Acid (μg./100 mg. wet wt.) | Succinoxidase (mm.$^3O_2$/100 mg. wet wt./hr.) | Protein N (mg./100 mg./wet wt.) |
|---|---|---|---|---|---|---|
| **Females** | | | | | | |
| Young | 10 | 65 ± 4.2* | 114 ± 6 | 325 ± 9 | 1964 ± 132 | 2.92 ± .05 |
| Old | 10 | 61 ± 4.2 | 94 ± 10 | 306 ± 6 | 1652 ± 164 | 2.88 ± .04 |
| $P_{diff.}$ | | NS | NS | NS | NS | NS |
| **Males** | | | | | | |
| Young | 10 | 59 ± 3.0 | 116 ± 5 | 301 ± 15 | 1772 ± 112 | 2.97 ± .08 |
| Old | 10 | 60 ± 4.3 | 116 ± 6 | 308 ± 8 | 1768 ± 124 | 2.88 ± .03 |
| $P_{diff.}$ | | NS | NS | NS | NS | NS |

* Mean and standard deviation of the mean.

crement was approximated by a similar reduction in the concentration of desoxyribose nucleic acid (8%). In contrast the age-dependent decreases in the concentrations of succinoxidase (18%) and succinic dehydrogenase (20%) exceeded those of the concentrations of desoxyribose nucleic acid. Similarly, a decrement in the concentration of cytochrome c oxidase (10%) was found in old rats in spite of a lack of significant change in the concentration of desoxyribose nucleic acid (table 1—experiment 2).

*Kidney—Males.* A tendency toward similar reductions with age was found when kidneys of male animals were examined. However, the differences were not always statistically significant (table 1).

*Heart.* A significant decrease in the concentration of succinoxidase (9%) of heart tissue of both male and female senescent animals was observed without a significant alteration in the concentration of desoxyribose nucleic acid (table 2).

*Liver.* No statistically significant aging changes were found in liver tissue (table 3).

## DISCUSSION

Decreases in the endogenous oxygen uptake and anaerobic glycolysis, based on the wet weight, dry weight, or nitrogen contents of tissues, have been a consistent finding when young growing animals have been compared with senescent ones (2). Since changes in the total number or proportions of various cells per unit wet weight of a tissue may occur during growth, it is difficult to distinguish between growth changes and changes which may be attributed to senescence. Therefore studies of senescence should include at least one group of animals known to be well beyond the growth phase as well as the senescent ones.

Estimates of the metabolic activity of individual cells are made difficult by the heterogenity of cellular types within the various organs and tissues. Although the distribution of different kinds of cells in a tissue preparation may be estimated by morphological examination, there is no readily available method for isolating specific cell types from a tissue and measuring their metabolic activities. However, the number of nuclei in a test sample may serve as a useful basis for comparing the metabolic activity of tissues from animals of different ages. Liver tissue is further complicated by the high degree of binucleation of hepatic but not of stromal cells (11). However, DNA content may still be used as an index of cellularity since the degree of binucleation is no different in young adult and senescent rats, although it is higher than either group in very young animals (11).

Estimates of the number of nuclei and the metabolic activity per unit wet weight of liver tissues are found in the data of Jacob and associates (5), and Ross and Ely (7), as well as the present study (table 4). The rates of endogenous oxygen uptake per unit wet weight are comparable in all these studies when the values obtained in the liver slices of the adult and senescent animals are examined. Although no age differences were observed in the present study, an agewise decrease in the oxygen uptake based on the wet weight of the samples was seen in the data of the first two investigations. The lower respiration of liver slices of

TABLE 4. RESPIRATION OF LIVER SLICES AND AGE OF THE RAT.

| Investigator | Sex | Age (Months) | Body Wt. (Gm.) | mm.$^3O_2$/mg. wet wt./hr. | Nuclei × $10^{-6}$/ Gm. wet wt. | mm.$^3O_2$ × $10^{-5}$/nucleus /hr. |
|---|---|---|---|---|---|---|
| Ross and Ely (7) | M | 1 | 35 – 45 | 1.51 ± 0.04* | 360† | 0.42† |
| | M | 5–6 | 160 – 170 | 1.20 ± 0.03 | 193 | 0.62 |
| | M | 21 | 450 – 500 | 1.03 ± 0.03 | 215 | 0.48 |
| Jacob (5) | F | 1 | 66 ± 2.0 | 1.82 ± 0.09 | 248† | 0.74 |
| | F | 2 | 129 ± 4.9 | 1.40 ± 0.11 | 163 | 0.85 |
| | F | "young adults" | 219 ± 12.7 | 1.22 ± 0.06 | 117 | 1.04 |
| | F | 24 | 245 ± 17.0 | 0.80 ± 0.08 | 135 | 0.60 |
| Present Study | M | 12–14 | 469 ± 20 | 1.16 ± 0.05 | 260 ± 21.1‡ | 0.45 ± 0.04 |
| | M | 24–27 | 433 ± 8.2 | 1.16 ± 0.06 | 266 ± 16.8 | 0.44 ± 0.04 |
| | F | 12–14 | 242 ± 3.6 | 1.14 ± 0.06 | 282 ± 14.4 | 0.40 ± 0.02 |
| | F | 24–27 | 283 ± 9.2 | 0.94 ± 0.10 | 246 ± 9.8 | 0.38 ± 0.03 |

* Mean and standard deviation of the mean.
† Calculated from mean values.
‡ Calculated from $\mu$g. DNA/100 mg. wet wt. tissue and $\mu$g. DNA x $10^{-6}$/nucleus as reported by Falzone, Barrows and Shock (3).

senescent rats as compared to that of 1-month-old animals may be explained by the marked reduction in the total number of nuclei per gram of liver. When the activities are expressed as the oxygen uptake per nucleus no difference between very young and senescent animals is seen. Although the degree of binucleation is markedly different in these two age groups, the percentage of hepatic to total liver cells decreases from 66% in the 1-month-old to 55% in the senescent rat (7). Calculations based on these values and adjusted for the degree of binucleation according to St. Aubin and Bucher (11) fail to demonstrate differences in the respiration of liver cells of very young and senescent rats. When the metabolic activity is based on the number of nuclei in the samples, a higher oxygen uptake per nucleus is found in young adult animals than in senescent or very young ones. Thus the decrement associated with senescence observed in these two experiments is dependent upon the high oxygen uptake per nucleus (or liver cell, since the degree of binucleation and percentage of hepatic cells are the same within these age groups) in the young adult animals. In both these experiments the number of nuclei per gram of liver in the young adult rats was lower than found in the senescent ones. This would tend to increase the calculated respiration per nucleus. Thus these discrepancies may be explained by the difficulties in estimating the number of nuclei in a test sample. The present study offers no evidence for a change related to senescence in the over-all metabolic activity of liver cells as measured by the total endogenous oxygen uptake or anaerobic glycolysis.

Similarly, the rate of endogenous oxygen uptake of kidney cells does not seem to decrease during senescence. For example, no marked agewise difference in the rate of respiration of kidney slices obtained from male animals was found. Although a reduction in the oxygen uptake of the kidney slices of aged female rats was observed, this decrement was essentially equal to the decrease in the concentration of desoxyribose nucleic acid. Assuming that the desoxyribose nucleic acid of kidney nucleus like that of liver nucleus is constant with age (3), these data suggest that, although fewer cells may be present per unit wet weight, the over-all metabolic activity per cell remains unchanged.

No age-dependent difference in the concentration of succinoxidase was found when liver was examined. However, a decrease in this enzymic activity was demonstrated in heart tissue of the senescent rats. Since no change in the concentration of desoxyribose nucleic acid was observed, a reduction in the concentration of succinoxidase per unit of heart tissue with age is inferred. Similarly, the greater decrement in the concentration of this enzyme as compared to that of the concentration of desoxyribose nucleic acid suggests that the kidney cells of senescent female rats also contain a reduced amount of this enzyme.

The activity of succinoxidase is dependent upon at least two individual enzymes, viz., succinic dehydrogenase and cytochrome c oxidase.

Therefore the decrement in the activity of this enzyme system may be a consequence of decreases in the concentration of one or both of these enzymes. In the assay for succinoxidase used in these studies succinic dehydrogenase is the limiting enzyme since only a small amount of reduced cytochrome c is produced during the reaction (8). Therefore kidney tissue was analyzed for maximal cytochrome c oxidase activity and the concentration of succinic dehydrogenase was measured by an independent method. With increasing age there was a decrement of approximately 10% in the activities of both enzymes based on the concentration of desoxyribose nucleic acid. It is generally believed that essentially all the activity of these enzymes is associated with the mitochondria of the cells (10). Therefore the uniform loss of these two independent enzymes indicates either a reduction in the activity of these enzymes per mitochondrion or a loss of mitochondria from kidney and possibly heart with increasing age. Data presently available cannot answer this question.

## SUMMARY

Measurements of the rates of endogenous oxygen uptake and anaerobic glycolysis of slices and the concentration of succinoxidase and desoxyribose nucleic acid of homogenates prepared from livers of 12-14-month-old and 24-27-month-old rats failed to indicate any agewise differences. The decreased rate of endogenous oxygen uptake observed in kidney slices of old female rats was essentially equal to the decrease in the concentration of desoxyribose nucleic acid. In contrast, the decrement in the concentration of succinoxidase, succinic dehydrogenase, and cytochrome c oxidase of kidney homogenates exceeded the reduction in the concentration of desoxyribose nucleic acid. A tendency toward similar aging changes was found when kidneys of male animals were examined, although the differences were not always statistically significant. A significant decrease with age in the concentration of succinoxidase of heart tissue was observed in spite of a lack of change in the concentration of desoxyribose nucleic acid.

These data offer no evidence for decrements related to aging in the over-all metabolism of tissues as measured by the endogenous oxygen uptake or anaerobic glycolysis. However, a significant decrease in the concentration of succinoxidase of kidney and heart, but not liver, was observed when 12-14-month-old and 24-27-month-old rats were compared. These decrements could not be accounted for solely by a decrease in the functioning cells in the tissues.

## REFERENCES

1. Barrows, C. H., Jr., McCollum, E. B., and Chow, B. F.: The Urinary Excretion of Vitamin $B_{12}$ Following Subcutaneous Administration to Young and Adult Rats with Different Reserves. *J. Nutrition, 47:* 525-538, 1952.
2. Barrows, C. H., Jr.: Cellular Metabolism and Aging. *Fed. Proc., 15:* 954-959, 1956.
3. Falzone, J. A., Jr. Barrows, C. H., Jr., and Shock, N. W.: Age Studies of the Mean DNA per Nucleus and the Degree of Polyploidy in Rat Liver (In press).
4. Hiller, A., Plazin, J., and Van Slyke, D. D.: A Study of Conditions for Kjeldahl Determination of Nitrogen in Proteins; Description of Methods with Mercury as Catalyst and Titrimetric and Gasometric Measurements of the Ammonia Formed. *J. Biol. Chem., 176:* 1401-1420, 1948.
5. Jacob, M., Mandel, L., and Mandel, P.: Etude de la Consommation d'Oxygéne et de la Teneur en Acide Désoxyribonucléique du Foie à Divers Ages chez le Rat. *Experientia, 10:* 218-220, 1954.
6. Kun, E., and Abood, L. G.: Colorimetric Estimation of Succinic Dehyrogenase by Triphenyltetrazolium Chloride. *Science, 109:* 144-146, 1949.
7. Ross, M. H., and Ely, J. O.: Aging and Enzyme Activity. *J. Franklin Inst., 258:* 63-66, 1954.
8. Schneider, W. C., and Potter, V. R.: The Assay of Animal Tissues for Respiratory Enzymes: II. Succinic Dehydrogenase and Cytochrome Oxidase. *J. Biol. Chem., 149:* 217-227, 1943.
9. Schneider, W. C.: Phosphorus Compounds in Animal Tissues. I. Extraction and Estimation of Desoxypentose Nucleic Acid and of Pentose Nucleic Acid. *J. Biol. Chem., 161:* 293-303, 1945.
10. Schneider, W. C.: Intracellular Distribution of Enzymes. I. The Distribution of Succinic Dehydrogenase, Cytochrome Oxidase, Adenosinetriphosphatase and Phosphorus Compounds in Normal Rat Tissues. *J. Biol. Chem., 165:* 585-593, 1946.
11. St. Aubin, P. M. G., and Bucher, N. L. R.: A Study of Binucleate Cell Counts in Resting and Regenerating Liver Employing a Mechanical Method for the Separation of Liver Cells. *Anat. Rec., 112:* 797-806, 1952.
12. Stumpf, P. K.: A Colorimetric Method for the Determination of Desoxyribose Nucleic Acid. *J. Biol. Chem., 169:* 367-371, 1947.

# AGE CHANGES IN THE CALCIUM CONTENT OF RAT BRAIN

E. STREICHER, Ph.D.*
*(From the National Institute of Mental Health, Bethesda)*

The relationship between aging and the calcium content of tissues has been reviewed by Heilbrunn (5) and Lansing (7). These investigators have pointed out the physiological significance of a possible age change in calcium and the issue is one of considerable systematic interest in gerontology. In the case of brain, an increase of tissue calcium with age has been reported in dogs and guinea pigs by Novi (10), for humans by Delbert and Breteau (2) and Bürger (1), and in rats by Freydberg-Lucas and Verzár (4). However, Lowry and associates (8) observed no significant differences in this respect between rats 20 and 33 months of age.

In reinvestigating this problem it was found that in young rats of the Sprague-Dawley strain, relatively large amounts of calcium may be deposited in the brain, presumably not in the parenchyma, since the calcium content of the two halves of the same brain often differed from each other by 100% or more (12). A basal value for calcium of 2-3 mEq./Kg. was reported for rat brain in agreement with the findings of Eichelberger and Richter on dog brain (3), and in agreement with the lowest figures reported in the literature for rat brain (11). The purpose of the present study was to characterize the temporal changes in the calcium content of rat brain throughout the life span.

## METHODS

Twenty-eight male and female Sprague-Dawley rats, 12-33 months old, were used in the present study. For purposes of comparison the results previously obtained on 9 animals 2.5-4 months of age have been included. All animals were maintained on Purina Laboratory Chow supplemented twice monthly with horse meat and kale. The methods employed in the preparation of the tissues for analysis have been previously described (12). Calcium was measured in quadruplicate by the method of Williams and Moser (15). Recoveries of known amounts of calcium that were carried through the entire procedure averaged 95.5% in 5 determinations. Each brain was divided in half longitudinally and the two halves were analyzed separately. Because of the unusually large interindividual and intraindividual variations in calcium that were encountered, statistical analyses were performed by means of the non-parametric Mann-Whitney "U" Test (9).

## RESULTS

The large variability in the calcium content of rat brain is evident from the data compiled in table 1. The values for the two halves of the same brain may differ markedly from one another. The majority of values in all age groups are in excess of 2-3 mEq./Kg., although in each group a few of the bilateral values were both within these limits, and the distribution of values was skewed toward the low end.

The mean for the 2.5-4-month-old animals was 5.2 mEq./Kg. and was similar to figures reported by others for rat brain (4, 8, 11, 13). The mean for the 12-month-old rats was 12.2, the highest average observed, and the only figure significantly higher ($p<.04$) than that of the youngest group. The means for the 12-month, 22-28-month, and 30-33-month-old groups were not significantly different from each other; the ranges were similar and no significant sex differences were observed.

The averages and medians of the lower values for each group increased continuously with age while those of the higher values were maximal in the 12-month-old group and decreased thereafter (fig. 1). This resulted in a decreased degree of bilateral asymmetry with age, so that in the oldest group the average of the lower values was not significantly different from that of the higher ones. Neither the right nor the left half of the brain consistently exhibited the higher of the two values.

## DISCUSSION

The age-associated rise in the level of rat brain calcium occurs within the first year of life in the group of experimental animals that

Submitted for publication July 21, 1958.
Presented in part at the Tenth Annual Meeting of the Gerontological Society, Inc., Cleveland, October 31, 1957.
Section on Aging, Laboratory of Psychology, National Institute of Mental Health, National Institutes of Health, Public Health Service, Bethesda, Maryland. The author wishes to acknowledge the capable technical assistance of Miss Millicent Rupp and Miss Susan Rupp.

TABLE 1. BILATERAL VALUES FOR CALCIUM OF RAT BRAIN (mEq./Kg.).

| Age (Months) | Sex | Lower Value | Higher Value | Average |
|---|---|---|---|---|
| 2.5-4 | M | 2.4 | 2.7* | 2.6 |
| | F | 2.3 | 3.6 | 3.0 |
| | F | 2.6 | 4.1 | 3.4 |
| | F | 2.5 | 7.4 | 5.0 |
| | M | 2.8* | 8.9 | 5.8 |
| | F | 3.0* | 10.9 | 7.0 |
| | F | 3.7 | 11.8 | 7.8 |
| | F | 4.0 | 9.1 | 6.6 |
| | F | 4.3 | 7.5 | 5.9 |
| | | 3.6 | 7.3 | 5.2 |
| 12 | M | 2.6 | 2.8* | 2.7 |
| | M | 2.4 | 10.1* | 6.2 |
| | M | 1.9 | 37.8* | 19.8 |
| | F | 2.8 | 46.6* | 24.7 |
| | F | 3.6 | 4.7 | 4.2 |
| | F | 4.0 | 8.1 | 6.0 |
| | F | 4.2 | 35.4* | 19.8 |
| | F | 8.0* | 8.4 | 8.2 |
| | M | 9.6* | 25.5 | 17.6 |
| | F | 11.7 | 14.3* | 13.0 |
| | | 5.1 | 19.4 | 12.2† |
| 22-28 | F | 2.5 | 2.7 | 2.6 |
| | F | 3.0 | 3.2 | 3.1 |
| | F | 3.1 | 14.3 | 8.7 |
| | M | 3.3 | 5.0* | 4.2 |
| | F | 4.2 | 5.1 | 4.6 |
| | F | 4.8 | 10.5 | 7.6 |
| | F | 6.2* | 33.9 | 20.0 |
| | M | 8.2 | 8.8 | 8.5 |
| | M | 9.3* | 21.8 | 15.6 |
| | M | 10.4 | 13.0 | 11.7 |
| | F | 12.8 | 14.7 | 13.8 |
| | | 6.2‡ | 12.1 | 9.1 |
| 30-33 | F | 2.2 | 2.2 | 2.2 |
| | M | 2.6 | 2.9* | 2.8 |
| | M | 1.6* | 5.3 | 3.4 |
| | F | 6.9* | 7.5 | 7.2 |
| | F | 7.6* | 9.6 | 8.6 |
| | F | 15.1 | 16.5* | 15.8 |
| | M | 20.5* | 29.8 | 25.2 |
| | | 8.1 | 10.5 | 9.3 |

* Right half of brain.
† Significantly higher than 2.5-4 month group ($P<.04$).
‡ Significantly higher than 2.5-4 month group ($P<.01$).

were used in this study. Previously, it had been demonstrated that mineralization of the brain starts within the first month after birth (12). However, in all age groups, some animals exhibit low calcium values considered characteristic for mammalian brain. The finding of Lowry and associates (8) was confirmed in so far as no significant differences were observed among groups of rats 12, 22-28, and 30-33 months of age.

It seems that the propensity for rats to deposit calcium in the brain is conditioned primarily by factors other than aging and senescence. For example, very high brain calcium levels averaging approximately 18 mEq./Kg. have been reported for young animals by Hess and associates (6). However, these values were reduced by ⅔ to ¾ by placing rats on diets deficient in calcium or vitamin D. (A concomitant reduction of brain inorganic phosphate was also induced by these diets). The average value for the brain calcium of 33-month-old rats of the Yale-Cornell strain was reported to be 3.3 mEq./Kg. (8), or approximately ⅓ the average value noted above for animals of the same age. On the other hand the values reported by Freydberg-Lucas and Verzár (4) for four 2-year-old rats varied approximately between 15-35 mEq./Kg., or about 2-3-fold the mean for this age group in the present study. Novi (10) also noted very large strain differences in the brain calcium of puppies from three separate litters. Finally, Wexler and Miller (14) produced extensive calcified arteriosclerotic lesions in the arterial wall of 1-year-old female Sprague-Dawley rats by the administration of ACTH. It therefore seems that the propensity of animals to deposit large and variable amounts of calcium in the brain may be the result of underlying genetic, dietary, and hormonal factors.

The prevalent bilateral asymmetry of rat brain calcium values and the magnitude of the values observed indicate that the deposition of the mineral in the brain occurs in nonparenchymal structures such as the blood vessels. This conclusion is indirectly supported by the tracer experiments of Freydberg-Lucas and Verzár (4) with $Ca^{45}$. They found that the total radioactivity of the brain 48 hours after

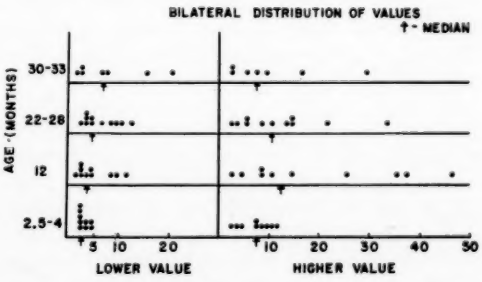


Fig. 1. Bilaterial distribution of calcium values in rat brain.

the administration of $Ca^{45}$ was approximately the same in animals 4-24 months of age, despite the fact that large differences in total calcium was observed. This may be interpreted to signify the existence of an exchangeable calcium pool that remains fairly uniform with age, together with a variable amount of non-exchangeable material which apparently increases with age.

In the presence of large and variable amounts of extracellular calcium, it is not possible to ascertain whether or not aging is associated with an increment in neuronal calcium. Presumably, the same considerations apply to previous studies concerned with the relationship of brain calcium to age as well as to analyses of other tissue in which large variations in calcium levels are observed (11, 13).

## SUMMARY

The calcium content of rat brain was measured in tissues from animals 2.5 to 33 months of age. The average value increased significantly during the first year and remained at approximately the same level for the succeeding 1.5 years. In each age group large individual variations were observed and the two halves of the same brain often differed markedly from each other. Most of the increment in calcium was presumably the result of nonparenchymal deposition of the element. It was concluded that the rise in brain calcium commonly associated with aging is mainly extracellular calcium and is the result of other underlying biological factors such as genetic, dietary, and hormonal influences. However, the relationship of aging to levels of cellular calcium remains unclarified, since a significant age change in neuronal calcium would be masked by the relatively large amounts of extracellular material.

## REFERENCES

1. Bürger, M.: Das Altern des Zentralnervensystems. In: *Experimental Research on Aging. Experientia Supplement IV.* Birkhäuser Verlag, Basel, 1956, pp. 101-111.
2. Delbet, P., and Breteau, P.: Vieillissement et Magnesium. *Bull. Acad. Med., 103:* 256-266, 1930.
3. Eichelberger, L., and Richter, R. B.: Water, Nitrogen, and Electrolyte Concentration in Brain. *J. Biol. Chem., 154:* 21-29, 1944.
4. Freydberg-Lucas, V., and Verzár, F.: Der Calciumstoffwechsel verschiedener Organe bei jungen und alten Tieren. *Gerontologia, 1:* 195-213, 1957.
5. Heilbrunn, L. V.: *An Outline of General Physiology,* 2nd ed. W. B. Saunders, Philadelphia, 1943, pp. 632-633.
6. Hess, A. F., Gross, J., Weinstock, M., and Berliner, F. S.: The Calcium and Phosphorus Content of the Brain in Experimental Rickets and Tetany. *J. Biol. Chem., 98:* 625-636, 1932.
7. Lansing, A. I.: General Physiology. Chapter 1 in: *Cowdry's Problems of Ageing,* 3rd ed. Williams and Wilkins, Baltimore, 1952, p. 3-22.
8. Lowry, O. H., Hastings, A. B., McCay, C. M., and Brown, A. N.: Histochemical Changes Associated with Aging. IV. Liver, Brain, and Kidney in the Rat. *J. Gerontol., 1:* 345-357, 1946.
9. Mann, H. B., and Whitney, D. R.: On a Test of Whether One of Two Random Variables is Stochastically Larger Than the Other. *Ann. Math. Stat. 18:* 50-60, 1947.
10. Novi, I.: Le Calcium et le Magnesium du Cerveau dans les Differents Âges. *Arch. Ital. Biol., 58:* 333-336, 1912.
11. Spector, W. S.: *Handbook of Biological Data.* W. B. Saunders, Philadelphia, 1956, Table 55.
12. Streicher, E.: Bilateral Asymmetry of Rat Brain Calcium. *Am. J. Physiol., 194:* 390-392, 1958.
13. Tufts, E. V., and Greenberg, D. M.: The Biochemistry of Magnesium Deficiency. I. Chemical Changes Resulting from Magnesium Deprivation. *J. Biol. Chem. 122:* 693-714, 1938.
14. Wexler, B. C., and Miller, B. F.: Severe Arteriosclerosis and Other Diseases in the Rat Produced by Corticotrophin. *Science, 127:* 590-591, 1958.
15. Williams, M. B., and Moser, J. H.: Colorimetric Determination of Calcium with Ammonium Purpurate. *Analyt. Chem., 25:* 1414-1417, 1953.

# EFFECTS OF CASTRATION AND/OR HORMONAL THERAPY UPON THE HEMATOCRIT IN AGED MALE RATS*

JEROME A. GRUNT, M.D., Ph.D., ROGER J. BERRY,† M.D., AND WILLIAM H. KNISELY,‡ Ph.D.

*(From the Departments of Anatomy and Medicine, Duke University School of Medicine, Durham, North Carolina)*

Previous work (4) demonstrated that the hematocrit in male rats increased with age from 50 to 115 days. Other findings (4) confirmed the work of several investigators (1, 8, 10), who observed that castration was followed by decrease in the hematocrit of male rats; and also substantiated observations (1, 2, 6, 8, 10, 11) that packed cell volume increased following testosterone treatment in castrated adult rats. It was also shown (4) that the hematocrit in young adult animals castrated on the day of birth was not significantly different from that in intact adult animals.

The effects of hormones on the blood have been reviewed by Kennedy and Gilbertsen (5), and extensive studies on the blood picture in the rat aged 1-350 days have recently been reported by Garcia (3), but little information is available about the aged animal. This study was designed to extend the observations to aged male rats.

## MATERIALS AND METHODS

Data from 44 aged (571-821 days) male rats of a locally inbred derivative of the Osborne-Mendel strain were compared with those from 40 of young animals (75-111 days) used in the previous study (4). As in the previous study (4), blood samples were taken at the time of laparotomy from a small tributary to the femoral vein; one end of a horizontal capillary tube was placed in the free-flowing blood. From 3 to 6 tubes were filled from one drop of blood; the average of readings from these tubes was designated the *hematocrit* for that animal. All tubes were centrifuged at 17,500 RPM for 2 minutes and read on the Drummond Microhematocrit reader according to the method of Strumia and associates (9).

Aged animals were divided into 6 treatment groups which were similar to some of those utilized in the previous study (4) (table 1). For purposes of comparison only, the data from the previous study (4) were included in table 1 as groups VII-X; these comprised treatment groups V, VI, VIII, and XII, respectively, in the previous report. Animals castrated 3 weeks prior to sacrifice are referred to as *castrates*, and those castrated on the day of birth are referred to as *neonatal castrates*. All injections were made subcutaneously for 7 days prior to sacrifice and consisted of 0.5 cc. sesame oil with or without 500 $\mu$g. testosterone propionate.*

The mean hematocrit was determined for each group and comparisons were made between groups. Data were analyzed by the paired-group method (using both Student's "t" and Chi Square) and significance determined with the aid of the tables of probability (7).

## RESULTS

The results are summarized in table 1. The hematocrit of young intact animals treated with sesame oil was higher than that of the aged animals, but the difference was not statistically significant; group I was not significantly different from that in group VII. Castration of aged animals was followed by a depression in the hematocrit; the values in group II were significantly lower than those in group I ($P<0.01$). Testosterone propionate did not bring about a return to normal levels; the mean hematocrit in group III was not higher than that in group II and was significantly lower than that in group I ($P<0.05$).

Castration was followed by a greater, although non-significant, fall in hematocrit in aged animals than in young animals; hence, comparison of the difference of the mean hematocrits of groups I and II with the difference of the mean hematocrit of groups VII and VIII was not statistically significant. After

Submitted for publication May 28, 1958.

* This investigation was supported in part by research grants from the Duke University Council on Research, the Durham-Orange County Heart Association, and the Duke University Regional Center for the Study of Aging. (Supported by the National Institute of Mental Health and National Heart Institute, USPHS).

† During tenure of USPHS Medical Student Research Fellowship.

‡ During tenure of a Research Fellowship of the American Heart Association. Senior Research Fellow USPHS.

* Testosterone Propionate was supplied by Ciba Pharmaceutical Products, Inc., Summit, New Jersey.

TABLE 1. GROUP ORGANIZATION AND DATA.

| Group No. | Treatment | Age in Days (Mean) | Number of Animals | Hematocrit (Mean) |
|---|---|---|---|---|
| I. | Aged intact animals, injected with sesame oil alone. | 571–821 (665) | 7 | 47.6±1.8* |
| II. | Aged castrate animals, injected with sesame oil alone. | 574–814 (694) | 7 | 41.7±0.8 |
| III. | Aged castrate animals, injected with sesame oil containing 500 μg. testosterone propionate. | 600–724 (671) | 7 | 42.7±0.9 |
| IV. | Aged neonatal castrates, otherwise untreated. | 574–765 (702) | 11 | 49.9±1.4 |
| V. | Aged neonatal castrates, injected with sesame oil alone. | 571–821 (700) | 6 | 44.3±1.9 |
| VI. | Aged neonatal castrates injected with sesame oil containing 500 μg. testosterone propionate. | 600–766 (680) | 6 | 48.0±1.0 |
| † VII. | Young intact animals, injected with sesame oil alone. | 77–102 (84) | 7 | 51.6±1.3 |
| VIII. | Young castrate animals, injected with sesame oil alone. | 77–102 (88) | 8 | 47.3±1.7 |
| IX. | Young castrate animals, injected with sesame oil containing 500 μg. testosterone propionate. | 75–108 (90) | 10 | 50.1±0.6 |
| X. | Young neonatal castrates, otherwise untreated. | 84–111 (96) | 15 | 50.9±1.0 |

* Standard error of mean.
† Groups VII-X from reference No. 4.

testosterone propionate there was a greater rise in the hematocrit of the young castrated animals than of aged castrates. However, this rise was not statistically significant when comparisons were made of the difference of the mean hematocrits of groups II and III with the difference of the mean hematocrits of groups VIII and IX.

The hematocrit in aged neonatally castrated animals was similar to that in aged intact animals (group V vs. group I) and was also similar to that in young neonatal castrates (group IV vs. group X, differences not statistically significant). Testosterone propionate did not significantly raise the hematocrit in aged neonatal castrates; thus the values in group VI were similar to those in group V.

## DISCUSSION

It has been shown that the hematocrit rises in young adulthood (3, 4). The present work demonstrates that the hematocrit is only slightly decreased in old age.

Castration was followed by a pronounced fall in the hematocrit in aged animals, and the level was not restored to normal by parenteral administration of testosterone propionate in an amount which tended to restore normal hematocrit levels in young adult castrates.

Thus it seems that the hematocrit of the old castrate may be somewhat less responsive to exogenus androgenic stimulation than is that of the young castrated rat. The fact that this difference in response was not statistically significant may be due to the small number of animals in each group. However, if the difference in response is verified, since both old and young animals were given the same amount of androgen, an explanation would have to be sought in the tissue reactivity rather than in the hormonal content. Thus it may be that the response of the hemopoetic system to androgenic stimulation may be decreased as the animal ages.

The hematocrit of aged neonatal castrates was similar to that of young adult neonatally castrated animals. The aged neonatal castrate seemed to show a greater response to exogenous androgen than did the adult castrate, although not statistically significant.

## SUMMARY

The hematocrit in aged male rats was only slightly lower than that of young adult animals.

Castration of aged males was followed by a depression in the hematocrit comparable to that in young adults, but normal levels were not restored by an amount of parental testosterone propionate which tended to return hematocrit values of castrated young adults to normal. These findings are discussed in relation to the effect of aging on the tissue reponsiveness to androgen.

## REFERENCES

1. Crafts, R. C.: Effects of Hypophysectomy, Castration, and Testosterone Propionate on Hemapoiesis in Adult Male Rat. *Endocrinology, 39:* 401-413, 1946.
2. Finkelstein, G., Gordon, A. S., and Charipper, H. A.: Effects of Sex Hormones on Hemorrhage-Induced Anemia in Rats. *Endocrinology, 35:* 267-277, 1944.
3. Garcia, J. F.: Changes in Blood, Plasma and Red Cell Volume in the Male Rat, as a Function of Age. *Am. J. Physiol., 190:* 19-24, 1957.
4. Grunt, J. A., Knisely, W. H., and Berry, R. J.: Effects of Age, Castration and/or Steroids upon Hematocrit in Male Rats. *Proc. Soc. Exper. Biol. & Med., 94:* 649-652, 1957.
5. Kennedy, B. J., and Gilbertsen, A. S.: Increased Erythropoiesis Induced by Androgenic-Hormone Therapy. *New England J. Med., 256:* 719-726, 1957.

6. Korenchevsky, V., and Hall, K.: Effects of Sex Hormones on the Blood in Rats. *J. Endocrinology, 4:* 103-108, 1945.

7. Snedecor, G. W.: *Statistical Methods.* Collegiate Press, Ames, 1946.

8. Steinglass, P., Gordon, A. S., and Charipper, H. A.: Effect of Castration and Sex Hormones on Blood of the Rat. *Proc. Soc. Exper. Biol. & Med., 48:* 169-177, 1941.

9. Strumia, M. M., Sample, A. B., and Hart, E. D.: Improved Microhematocrit Method. *Am. J. Clin. Path., 24:* 1016-1024, 1954.

10. Van Dyke, D. C., Contopoulas, A. N., Williams, B. S., Simpson, M. E., Lawrence, J. H., and Evans, H. M.: Hormonal Factors Influencing Erythropoiesis. *Acta haemat., 11:* 203-222, 1954.

11. Vollmer, E. P., and Gordon, A. S.: Effects of Sex and Gonadotropic Hormone upon the Blood Picture of the Rat. *Endocrinology, 29:* 829-837, 1941.

# MUCOPOLYSACCHARIDES OF HUMAN ARTERIAL TISSUE*

## IV. Analysis of Electrophoretically Separated Fractions

J. E. KIRK, M.D., I. WANG, M. S., AND M. DYRBYE, M. D.
*(From the Division of Gerontology, Washington University School of Medicine, St. Louis)*

In a recent publication from this laboratory (6) the separation by paper electrophoresis of two mucopolysaccharide fractions from mucopolysaccharide material isolated from human aortic tissue was reported. Both fractions showed metachromatic staining with toluidine blue, and the faster moving component was found to possess a mobility similar to that of chrondroitin sulfate. The present study was undertaken with the purpose of characterizing the fractions through determination of their contents of total hexosamine, galactosamine, glucosamine, uronic acid, and sulfate. Because of the small quantities of mucopolysaccharide material present in the eluates the reported analytical values should be considered as approximate only.

### MATERIAL AND METHODS

The 30 samples of mucopolysaccharide material which had previously been isolated from human aortas (5) were included in the study.

#### *Total hexosamine, galactosamine, glucosamine, and uronic acid*

Material was provided for determination of the percentage contents of these compounds in the two mucopolysaccharide fractions by carrying out electrophoresis experiments on the aortic mucopolysaccharide samples with a Spinco Model R apparatus and elution of the paper strips of the samples and blanks as reported in a recent publication (6). The concentration of total mucopolysaccharide in each eluate was assayed by the turbidimetric procedure of Di Ferrante (2). The total hexosamine, galactosamine, and glucosamine contents of the eluates were determined by means of methods previously described (8).

For estimation of uronic acid only the colorimetric carbazole method of Dische (3, 4) was used since sufficient material was not available for gasometric assay by Tracey's procedure. Tubes provided with ground glass stoppers were employed for color development of the samples (8). The eluates were carefully centrifuged to remove traces of filter paper. In order to obtain a high degree of sensitivity a suitable aliquot of the supernatant of the eluate was evaporated to dryness in a tube; 0.5 ml. of distilled water was then pipetted into the tube and the subsequent part of the procedure carried out with one-half of the usual volume of the reagents. The colorimetric measurements were made by means of a Beckman DU spectrophotometer, using quartz cuvettes. Since the Spinco electrophoresis cell after some time's usage was found to give off material which interfered with the uronic acid determinations successive cells were employed in the electrophoresis experiments to provide uncontaminated eluates for the uronic acid determinations.

#### *Sulfate*

Contamination from the electrophoresis cell which interfered with the determination of sulfate was also encountered. For this reason a special electrophoresis cell was assembled for electrophoretic separation of the mucopolysaccharide fractions for sulfate analyses. Two glass troughs, supplied with platinum wires, were placed inside the Spinco cell vessel; these troughs served as containers for the buffer solution. The Spinco support stand was employed to insure the usual position of the paper strips. In order to avoid possible contamination from the rubber pecks the use of the Spinco rack was omitted; instead, the constant immersion of the free ends of the paper strips into the buffer solution was secured by means of a glass rod placed horizontally in each trough. The apparatus was closed with the Spinco cell cover and during operation was connected with the Spinco Duostat. The paper strips before use were rinsed in successive sets of glass-distilled water to remove traces of sulfate.

Because the glass troughs of the assembled apparatus could accomodate only a small number of paper strips, two sample paper strips and two blank strips were used for each aortic mucopolysaccharide sample. At the conclusion of the electrophoresis experiments each of the two bands on the sample strips and corresponding areas on the blank strips were eluted with 4.0 ml. of water as previously described (6). In view of the comparatively small quantities of mucopolysaccharide material present in the eluates it was considered advisable to employ an analytical technique for the sulfate determinations which was even more sensitive than the spectrophotometric benzidine method previously used (8). The procedure chosen was a modification of Keily and Rogers' (7) nephelometric method. The main changes of Keily and Rogers' technique consisted of carrying out the turbidity development at pH 6.0 instead of 1.0 and in the adding of sodium chloride to the medium. Both the use of a near neutral reaction and the presence of sodium chloride were found to be of significance in producing reproducible readings, probably through the effect of these factors in inhibiting the growth of the barium sulfate microcrystals.

For the sulfate analyses 500 cu. mm. of each sample

Submitted for publication July 14, 1958.
* Studies on Arterial Metabolism XXII. The investigation was supported by a grant (PHS-891) from the National Heart Institute of the National Institutes of Health, Public Health Service. A partial report of the results of the study was given at the Tenth Annual Meeting of the American Society for the Study of Arteriosclerosis, Chicago, November 11-12, 1956.

eluate or blank eluate were pipetted into a platinum crucible, and 100 cu. mm. of a 0.25 mM solution of Mg $(NO_3)_2$, 6 $H_2O$ were added. The contents of the crucible were subsequently evaporated to dryness under an infrared lamp. The ashing of the sample was accomplished by heating the crucible for one minute over a microburner; 500 cu. mm. of 0.1 N HCl were then added and heated briefly to near boiling. After cooling, the contents of the crucible were transferred quantitatively by means of successive small portions of glass-distilled water to a test tube, and 1.0 ml. of an acetate buffer solution (1.0 N sodium acetate, 0.75 N NaCl, pH 6.0) was added, followed by 1.3 ml. of 95% ethyl alcohol. The contents of the tube were made up to 6.0 ml. with distilled water, and, after thorough mixing, 36 mg. of solid $BaCl_2$, $2H_2O$, 20-30 mesh (Parr Instrument Co.) were added with a scoop. The tube was then shaken continuously at a steady rate until the barium chloride had dissolved, which generally required about 6 minutes. Following this, the tube was again shaken (for 10 seconds only) at 9 and 12 minutes after the addition of the barium chloride.

The nephelometric measurements were made exactly 18 minutes after the barium chloride addition, using a

TABLE 1. COMPOSITION OF ELECTROPHORETICALLY SEPARATED MUCOPOLYSACCHARIDE FRACTIONS OF INDIVIDUAL AORTIC SAMPLES.

| | | Faster Moving Fraction | | | | | Slower Moving Fraction | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample No. | Age (Yrs.) | Total Hexosamine % | Galactosamine % of Hexosamine | Glucosamine % of Hexosamine | Uronic Acid % | $SO_4$ % | Total Hexosamine % | Galactosamine of % Hexosamine | Glucosamine % of Hexosamine | Uronic Acid % | $SO_4$ % |
| 1 | 1 | 27 | 100 | 0 | 18 | .. | 21 | .. | .. | 19 | .. |
| 2 | 3 | 13 | ... | .. | 32 | 15 | 15 | .. | .. | 24 | 17 |
| 3 | 3 | 22 | 100 | 0 | 33 | .. | 28 | 56 | 44 | .. | .. |
| 4 | 5 | 31 | 100 | 0 | 29 | 18 | 24 | 59 | 41 | 29 | .. |
| 5 | 8 | 23 | 100 | 0 | 32 | .. | 22 | 57 | 43 | 22 | .. |
| | Mean | 23 | 100 | 0 | 29 | 17 | 22 | 57 | 43 | 24 | 17 |
| 6 | 25 | 20 | 100 | 0 | 27 | 16 | 27 | 55 | 45 | 28 | 18 |
| 7 | 29 | 32 | 100 | 0 | 32 | 31 | 26 | .. | .. | 28 | 25 |
| 8 | 33 | 24 | 100 | 0 | 25 | .. | 22 | 45 | 55 | 41 | .. |
| 9 | 38 | 23 | 100 | 0 | 28 | 25 | 16 | .. | .. | 30 | 19 |
| 10 | 39 | 26 | 100 | 0 | 24 | 31 | 23 | 54 | 46 | 23 | 25 |
| | Mean | 25 | 100 | 0 | 27 | 26 | 23 | 51 | 49 | 30 | 22 |
| 11 | 41 | 23 | 100 | 0 | 29 | 10 | 26 | 59 | 41 | 31 | 6 |
| 12 | 46 | 32 | 100 | 0 | 23 | .. | 15 | .. | .. | .. | .. |
| 13 | 46 | 21 | 100 | 0 | 28 | 20 | 24 | 67 | 33 | 28 | 9 |
| 14 | 49 | 26 | 100 | 0 | 31 | 24 | 21 | 46 | 54 | 27 | 7 |
| 15 | 49 | 19 | 100 | 0 | 23 | .. | 16 | 42 | 58 | 26 | .. |
| | Mean | 24 | 100 | 0 | 27 | 18 | 20 | 54 | 46 | 28 | 7 |
| 16 | 50 | 23 | 100 | 0 | 27 | 23 | 25 | 55 | 45 | 31 | 8 |
| 17 | 50 | 15 | 100 | 0 | 27 | 24 | 20 | 44 | 56 | 28 | 19 |
| 18 | 51 | 25 | ... | .. | 24 | 43 | 18 | .. | .. | 24 | 25 |
| 19 | 52 | 27 | 100 | 0 | 27 | 31 | 17 | 62 | 38 | 37 | 24 |
| 20 | 53 | 25 | 100 | 0 | 25 | .. | 18 | 53 | 47 | 24 | .. |
| 21 | 53 | 29 | 100 | 0 | 27 | .. | 20 | .. | .. | 28 | .. |
| 22 | 54 | 25 | 100 | 0 | 27 | 28 | 19 | 62 | 38 | .. | 23 |
| 23 | 56 | 17 | 100 | 0 | 23 | 14 | 28 | .. | .. | 36 | 11 |
| 24 | 58 | 24 | 100 | 0 | 29 | 17 | 27 | 59 | 41 | 40 | 10 |
| | Mean | 23 | 100 | 0 | 26 | 26 | 21 | 56 | 44 | 31 | 17 |
| 25 | 65 | 24 | 100 | 0 | 28 | 16 | 29 | 57 | 43 | 26 | 12 |
| 26 | 66 | 20 | 100 | 0 | 24 | 16 | 19 | 59 | 41 | 23 | 13 |
| 27 | 68 | 23 | 100 | 0 | 29 | .. | 16 | 61 | 39 | 26 | .. |
| 28 | 76 | 29 | 100 | 0 | 31 | .. | 35 | .. | .. | 23 | .. |
| 29 | 76 | 18 | 100 | 0 | .. | 15 | 18 | 68 | 32 | .. | 20 |
| 30 | 76 | 29 | 100 | 0 | 27 | 18 | 26 | 56 | 44 | 27 | 6 |
| | Mean | 24 | 100 | 0 | 28 | 16 | 24 | 60 | 40 | 25 | 13 |
| Grand Mean | | 24 | 100 | 0 | 27 | 22 | 22 | 56 | 44 | 28 | 16 |

Coleman No. 14 spectrophotometer with nephelometric equipment. A light source of 560 millimicrons and cuvettes No. 11-127, placed in a fixed position on the carrier, were employed. The nephelometric readings were made by means of the drum scale of the apparatus. A reagent blank was run with each set of analyses. The ashing procedure and nephelometric determinations yielded reproducible results with standard solutions of sodium sulfate and a commercial chondroitin sulfate preparation.

For calculation of the sulfate percentage of the mucopolysaccharide fractions the total mucopolysaccharide content of the samples was estimated by carrying out determinations on 1.0 ml. aliquots of the same eluates by Dische's carbazol method; in these analyses the procedure described above with the use of one-half of the usual volumes of reagents was employed.

## RESULTS

The results of analyses performed on the two components of the 30 arterial mucopolysaccharide samples included in the study have been listed in table 1. It will be seen from the reported values that the mean hexosamine concentrations of the two fractions were approximately the same, namely 24 and 22%. It is of significance to note that whereas all the amino sugar of the faster moving fraction proved to be galactosamine,* the hexosamine of the slower moving fraction was found to be composed of both galactosamine and glucosamine, the average percentage values of these compounds being, repectively, 56 and 44%. Although occasional samples showed comparatively low uronic acid values as determined by the carbazole reaction, no great difference was noted between the mean uronic acid values of the two fractions. In contrast to this, the average sulfate ($SO_4$) content of the faster moving fraction (22%) was found to be significantly higher than that of the slower moving fraction (16%), the t value of the difference between the mean sulfate values of the two mucopolysaccharide components being 2.57 ($p=0.02$).

No significant change with age was observed in the total hexosamine, galactosamine, glucosamine, and uronic acid content of the fractions; the sulfate determinations included in the investigation were too few to permit an evaluation of age dependency.

## DISCUSSION

The present investigation has revealed a definite difference in the compositions of the two metachromatically staining aortic mucopolysaccharide components separated by paper electrophoresis. Since only comparatively small quantities of material are obtainable through this technique more extensive studies on these fractions have not been possible. For this reason the results do not permit decisive conclusions with regard to the exact type of acid mucopolysaccharides present in the two components, but on the basis of the mobility of the faster moving fraction and its exclusive content of galactosamine it seems reasonable to assume that this fraction contains chrondroitin sulfate. Although no reports are available in the literature on the composition of mucopolysaccharide fractions prepared from human arterial tissue it is of interest to note that chondroitin sulfates A (1, 9), B (1, 10), and C (10), hyaluronic acid (1, 9), and a fraction containing N-acetyl-glucosamine, uronic acid, and varying amounts of sulfate (9) have been isolated from the aorta of cattle. It should be recalled in this connection that the present study included only mucopolysaccaride components which stained metachromatically with toluidine blue.

## SUMMARY

Two metachromatically staining fractions of acid mucopolysaccharides separated through paper electrophoresis from material isolated from 30 samples of human aortic tissues were subjected to chemical analyses. Determinations were made of the total hexosamine, galactosamine, glucosamine, uronic acid (colorimetric), and sulfate content of the fractions.

The faster moving fraction, which possessed a mobility similar to that of chondroitin sulfate, showed the following mean values: total hexosamine, 24%; uronic acid, 27%; and sulfate, 22%. All the amino sugar of this fraction was found to be galactosamine.

The average composition of the slower moving fraction was: total hexosamine, 22%; uronic acid, 28%; and sulfate, 16%. Galactosamine constituted 56% and glucosamine 44% of the hexosamine of this fraction.

No significant variation with age in the composition of the two fractions was observed.

## REFERENCES

1. Berenson, G. S.: A Study of Acid Mucopolysaccharides of Bovine Aorta with the Aid of a Chromatographic Procedure for Separating Sulfated Mucopolysaccharides. *Biochim. Biophys. Acta, 28:* 176-183, 1958.
2. Di Ferrante, N.: Turbidimetric Measurement of Acid Mucopolysaccharides and Hyaluronidase Activity. *J. Biol. Chem., 220:* 303-306, 1956.

* The presence of glucosamine in this fraction in quantities too small to produce a visible spot on staining of the chromatograms cannot be excluded.

3. Dische, Z.: A New Specific Color Reaction for Hexuronic Acids. *J. Biol. Chem., 167:* 189-198, 1947.

4. Dische, Z.: New Color Reactions for Determination of Sugars in Polysaccharides. In: *Methods of Biochemical Analysis, 2:* 313-358, 1955. Interscience Publishers, Inc., New York.

5. Dyrbye, M., and Kirk, J. E.: Mucopolysaccharides of Human Arterial Tissue. I. Isolation of Mucopolysaccharide Material. *J. Gerontol., 12:* 20-22, 1957.

6. Dyrbye, M., Kirk, J. E., and Wang, I.: Mucopolysaccharides of Human Arterial Tissue. III. Separation of Fractions by Paper Electrophoresis. *J. Gerontol., 13:* 149-151, 1958.

7. Keily, H. J., and Rogers, L. B.: Nephelometric Determination of Sulfate Impurity in Certain Reagent Grade Salts. *Analyt. Chem., 27:* 759-764, 1955.

8. Kirk, J. E., and Dyrbye, M.: Mucopolysaccharides of Human Arterial Tissue. II. Analysis of Total Isolated Mucopolysaccharide Material. *J. Gerontol., 12:* 23-31, 1957.

9. Meyer, K., Davidson, E., Linker, A., and Hoffman, P.: The Acid Mucopolysaccharides of Connective Tissue. *Biochim. Biophys. Acta, 21:* 506-518, 1956.

10. Meyer, K., and Rapport, M. M.: The Mucopolysaccharides of the Ground Substance of Connective Tissue. *Science, 113:* 596-599, 1951.

# THE FUNCTIONAL SIGNIFICANCE OF MUCOPOLYSACCHARIDE OBTAINED FROM CATTLE AORTA*

SHIU YEH YU, M.S., AND HERMAN T. BLUMENTHAL, Ph.D., M.D.
*(From the Institute of Experimental Pathology, The Jewish Hospital, and the Department of Pathology, St. Louis University, School of Medicine, St. Louis)*

In recent years considerable interest has developed regarding alterations in the ground substance of various tissues and organs with aging. Particular attention has been directed to changes in the mucopolysaccharides, an important component of this material. Thus Stidworthy and associates (43) have studied the effect of aging on the mucopolysaccharide composition of costal cartilage; Sobel and associates (42), of dermal biopsies from man; and Dyrbye and Kirk (16), of human aorta. While, in general, these studies have shown either a relative or an absolute decrease in certain of the components of ground substance with advancing age, the functional significance of such observations have not been elucidated.

Alterations in the composition and quantity of ground substance in arterial tissue in aging processes would seem to have particular significance, since in vessels such changes may be expected to have physical as well as metabolic effects. At present the ground substance in arteries is considered to have a dual function: 1) To act as a lubricant, facilitating the movement of structural components over one another, and 2) As a cement substance binding together certain structural units. Of particular importance is the role of ground substance in the structure and function of elastic lamellae. In its lubricant action it facilitates the extension and rebound of the elastic fiber as it extends and rebounds with the expansion and contraction of the vessel wall. As regards its role as a cement substance, the reports of Hall and associates (21, 22), and Lansing and coworkers (25) have shown that the basic unit of the elastic lamella is the elastic fibril, groups of which seem to be cemented together to form the elastic fiber. Such fibers are interwoven much like the strands of a rope and again are cemented to each other by ground substance. The resulting rope-like structure which constitutes the elastic lamella is encased in an envelope also composed of mucopolysaccharide (10).

The present study deals with a mucopolysaccharide-containing material obtained from cattle aorta, with which we have been able to demonstrate certain additional functional characteristics which seem to be particularly important in aging processes in arteries. Specifically, these studies demonstrate an elastase-inhibiting and a blood anticoagulant activity of this material. The anticoagulant activity of mucopolysaccharides isolated from arterial tissues has also been studied by Jorpes (23), Berenson (9), Bassuini (7), and by Meyer and co-workers (31).

## MATERIAL AND METHODS

*Isolation of aortic mucopolysaccharide.* Aortas were obtained from 2-year-old cattle. The adipose tissue was first dissected away and the remaining tissue ground in a meat grinder. This mince was then dehydrated and defatted by serial immersion in increasing percentages of cold alcohol, ranging from 70 to 100%. It was subsequently placed in a cold mixture of alcohol and ether and finally in cold ether. Each step was carried out at 4 C. for 24 hours. The material was then passed through a 20-mesh screen in a Wiley mill, and finally extracted twice with cold ether, filtered, and dried.

Two hundred Gm. of this defatted and desiccated powder was suspended in 4 liters of water, adjusted to pH 9.5 with 5 N NaOH, following which 50 ml. of 0.05 M phosphate buffer (pH 7.5), 5 Gm. of viokase* and 10 ml. of toluene were added. The mixture was incubated for 24 hours at 37 C. and adjusted to pH 9.0 every 4 hours. It was then adjusted to pH 6.0 with HCl and incubated with 500 mg. of papain† for 48 hours. Subsequent incubation with viokase was again repeated twice for 24-hour periods.

Submitted for publication July 15, 1958.
* This investigation was supported in part by Grant H 2571 from the Department of Health, Education, and Welfare, National Institutes of Health, U. S. Public Health Service, and in part by the David May-Florence G. May and Louis Monheimer Memorial Research Funds.

* Viokase—(Viobin Corporation, Monticello, N. Y.)
† Papain—(Worthington Biochemical Corp., Freehold, N. J.)

The resultant viscous substance was separated by centrifugation, the supernatant acidified to pH 6.5 with HCl, two volumes of 95% alcohol added, and the solution allowed to stand for 24 hours at 4 C. The precipitate which formed was separated by centrifugation, washed 5 times with cold 30% acidified alcohol, and finally with 100% alcohol. This preparation was then incubated at 37 C. with 2 mg. of pure elastase* in 0.10 M borate buffer at pH 8.0 for about 12 hours. It was then reprecipitated in acidified cold alcohol, centrifuged, washed 5 times with cold 30% alcohol, and finally with 100% alcohol.

A part of this preparation was suspended in water, adjusted to pH 7.5 with 0.05 M NaOH, and lyophilized. It was then redissolved in water in the form of a sodium salt to insure its solubility and used in this form for functional studies. The final yield of polysaccharide-protein complex from 200 Gm. of defatted dried cattle aorta was approximately 1 Gm.

The product was analyzed as regards its elemental content, its content of hexosamine (17), hydroxyproline (45), proline (44), and protein (28). It was also studied electrophoretically, and a qualitative amino-acid analysis was carried out by paper chromatography.

*Demonstration of inhibition of elastase.* The ability of this material to inhibit elastase was compared with commercial heparin and with chondroitin sulfate. Such inhibition was first tested, utilizing the colorimetric procedure of Sachar and associates (40), with dried aorta and ligament elastin substrate prepared by the method of Lowry and associates (27). Inhibition studies were also attempted, utilizing carbobenzoxyglycyl - L - phenylalanine, a synthetic substrate, and here too the isolated mucopolysaccharide was compared with commercial heparin.

The elastase inhibiting ability of the aortic mucopolysaccharide was also studied microscopically. The elastin substrate prepared by the technique of Lowry and associates (27) was first stained with orcein and then incubated with the mucopolysaccharide or heparin for 20 minutes. Following this, elastase was added and incubation continued for an additional 20 minutes. The mixture was then washed with phosphate buffer (pH 6.0)) to remove the elastase, spreads made on slides, and the material dried and examined with the ordinary light microscope as well as by phase contrast microscopy.

*Demonstration of anticoagulant activity.* An in vitro comparison of the anticoagulant activity of the mucopolysaccharide with standard commercial sodium heparinate (U.S.P. 100,000 units/Gm.) was carried out by a modification of the method of Belko and Warren (8). A.C.D. blood was used in these experiments, i.e., each 100 ml. of blood contained 0.44 Gm. anhydrous citric acid, 1.32 Gm. of sodium citrate, and 1.47 Gm. of dextrose. Five ml. of whole blood were added to 0.4 ml. of thromboplastin solution (Warner-Chilcott "Simplastin") in 15 ml. test tubes. To this mixture was added 0.1 ml. of various dilutions of mucopolysaccharide or heparin. The tubes were stoppered and the contents gently mixed. They were then placed in a water bath at 37 C. for 10 minutes, at which time 0.5 ml. of 0.04 M calcium chloride was blown in, and the stop watch started. A wooden applicator was used to observe fibrin formation due to clotting. Concentrations of either heparin or mucopolysaccharide were considered to have an anticoagulant effect when no fibrin was detected between 6 and 15 minutes.

## RESULTS

*Chemical characteristics of the mucopolysaccharide material.* Elemental analysis of the material obtained from cattle aorta yielded the following composition:

| | |
|---|---|
| Carbon | 45.6% |
| Hydrogen | 6.7% |
| Nitrogen | 11.6% |
| Sulfur | 0.8% |
| Ash | 2.3% |
| Difference | 33.0% |

Analysis for other substances yielded the following additional information as regards the composition of this material.

| | |
|---|---|
| Hexosamine | 16.7% |
| Hydroxyproline | 0.0% |
| Proline | 2.6% |
| Protein | 38.7% |

Electrophoretic studies of the preparation showed the major component to have a slow-moving, ninhydrin positive characteristic. There were also two or three minor, fast-moving components giving a relatively less intense color with ninhydrin.

* Elastase—(Merck & Co., Rahway, N. J.)

The amino acid composition of the mucopolysaccharide as determined by paper chromatography showed the following major constituents: glycine, alanine, valine, proline, leucine, isoleucine, glutamic acid, aspartic acid, tyrosine, and serine. There were traces of others which were not specifically identified. Although a quantitative amino acid analysis was not carried out, the amino acid composition of the mucopolysaccharide seems to resemble more closely that reported by Lansing and associates (24) for elastin than that which is generally considered characteristic of collagen. This conclusion is based not only on the identity of the amino acids, but also as regards the relative quantity of each as judged by the intensity of the spots on the chromatograms.

From these data it was concluded that this substance seemed to be a protein conjugated mucopolysaccharide similar to that reported by Malawista and Schubert (29). The minor components observed in the electrophoretic studies were believed possibly to contain free acidic groups.

*Biochemical demonstration of elastase inhibition by mucopolysaccharide.* The ability of this material to inhibit elastase activity is demonstrated in table 1, where the inhibition-potency on a mg.-for-mg. basis is compared with commercial heparin. It is evident that the material obtained from cattle aorta is only slightly less effective than heparin. Thus, 40 mg. of the mucopolysaccharide produced a 74.5% inhibition as compared with 80.8% by an identical quantity of heparin.

TABLE 1. MUCOPOLYSACCHARIDE INHIBITION OF ELASTOLYSIS BY ELASTASE.

| Mucopolysaccharide of Cattle Aorta (mg.) | Elastin Substrate (mg.) | Mg. of Elastin Hydrolyzed* (mg.) | % Inhibition |
|---|---|---|---|
| 0 | 20 | 7.17 | .0 |
| 1 | 20 | 6.73 | 5.9 |
| 10 | 20 | 6.32 | 11.7 |
| 15 | 20 | 5.34 | 25.3 |
| 20 | 20 | 4.36 | 39.0 |
| 40 | 20 | 1.82 | 74.5 |
| Sodium Heparin† | | | |
| 1.7 | 20 | 6.89 | 3.6 |
| 2.9 | 20 | 6.12 | 14.4 |
| 14.0 | 20 | 5.89 | 17.6 |
| 20.0 | 20 | 4.32 | 35.9 |
| 30.0 | 20 | 2.75 | 61.5 |
| 40.0 | 20 | 1.37 | 80.8 |
| Chondroitin Sulphate‡ | | | |
| 2.0 | 20 | 6.47 | 9.5 |
| 5.5 | 20 | 4.73 | 33.8 |
| 20.0 | 20 | 4.65 | 35.0 |
| 30.0 | 20 | 4.24 | 40.6 |
| 40.0 | 20 | 3.10 | 56.6 |

* Per 20 minutes by 1 mg. elastase.
† U.S.P., 100,000 units per Gm.
‡ Chondroitin Sulfate (Worthington Biochemical Corp., Freehold, N. J.) was prepared from bovine cartilage.

Table 1 also contains a comparison with a chondroitin sulfate which is predominantly of the A type. The inhibition of elastase on a mg.-for-mg. basis, at concentrations up to 20 mg., is of the same magnitude as the cattle aorta mucopolysaccharide-protein complex as well as heparin, but at higher concentrations its inhibiting ability is less than the latter two.

Inhibition studies with the synthetic substrate carbobenzoxyglycyl-L-phenylalanine, which has been shown in another study to be split by elastase (47), resulted in no inhibition by either the aortic mucopolysaccharide or heparin.

*Structural demonstration of inhibition of elastase by mucopolysaccharide.* Lansing and associates (25) have observed that the hydrolysis of elastin by elastase is usually rapid and complete, leaving only an amorphous debris which can be demonstrated microscopically. The elastin substrate as prepared by the method of Lowry and associates (27) shows fragments of fibers composed of a matrix which stains densely with orcein or other elastic tissue stains, around which there is sometimes a suggestion of a thin, clear membrane; but more often the fibers appear naked (fig. 1). If the substrate is pretreated with either heparin, chondroitin sulfate derived from cartilage, or aortic polysaccharide, a distinct coating forms on the surface of the fibers, including the broken ends. When such pretreated substrates are then incubated with elastase, most of the fibers remain intact and there is no change in the coating material (figs. 2 and 3).

Fig. 1. Elastic tissue fibers of ligamentum nuchae prepared by the technique of Lowry (27). Specimen has not been pretreated or exposed to elastase. Mag. 500X, Orcein Stain.

Fig. 2. Elastic tissue fibers prepared as in previous figure, but pretreated with heparin and incubated with elastase. Note intact state of fibers, which have a thin transparent coating. Mag. 500X, Orcein Stain.

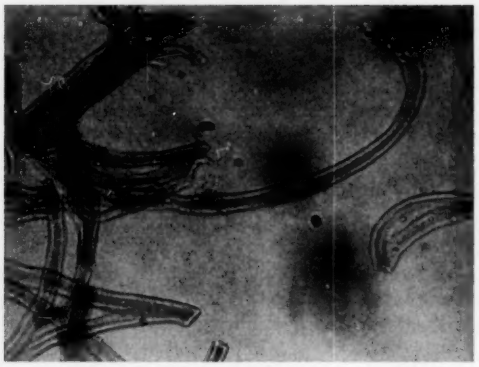

Fig. 3. Elastic tissue fibers prepared as in figure 1, but pretreated with aortic mucopolysaccharide and incubated with elastase. Here too fibers remain intact, and the coating is even more striking than in figure 2. Mag. 500X, Orcein Stain.

*Comparison of anticoagulant activity of heparin and aortic mucopolysaccharide.* The averages of several comparisons of anticoagulant activity of heparin and aortic mucopolysaccharide were as follows:

Minimum quantity of heparin required for prevention of clotting—0.14 mg.

Minimum quantity of polysaccharide required for prevention of clotting—3.34 mg.

Ratio—heparin/polysaccharide on a mg.-for-mg. basis—1/23.6.

Since Chargaff and associates (13) have shown that the anticoagulant activity of both artificial and natural polysaccharide may be related to their sulphate content, a further comparison was made on the basis of the sulphur content of each of these substances, based on the observation of Jorpes (23) that a highly active preparation of heparin in the form of the sodium salt contains 13.6% of sulphur. Thus,

$$\frac{S \text{ (Heparin)}}{S \text{ (Mucopolysaccharide)}} = \frac{.14 \times .136}{3.34 \times .008} = \frac{1}{1.4}$$

It is evident that on a mg.-for-mg. basis the aortic mucopolysaccharide has about 4% of the anticoagulant activity of heparin. Nevertheless, the calculation on the basis of sulphur content would seem to substantiate the view of Chargaff and associates (13), since the ratio approaches unity. A further consideration as regards the comparative anticoagulant potency of the mucopolysaccharide-protein complex and commercial heparin is the fact that the latter is not bound to protein. Thus, if the protein-structure were removed from the mucopolysaccharide or added to the heparin, the difference in percentage of sulphur would be smaller. However, Marbet and Winterstein (30) have reported that, in addition, the stereochemical nature of a compound may also be important in determining its anticoagulant activity, and this may explain why the value of the ratio obtained on the basis of sulphur content is not absolute unity.

## DISCUSSION

Utilizing extraction procedures, a number of investigators (7, 9, 23, 31, 32) have isolated several acid mucopolysaccharides from the aortic wall; among these are chondroitin sulfate A, chondroitin sulfate B, hyaluronic acid, and heparin or heparin-like substances with varying degrees of sulfation. The techniques utilized in preparing these mucopolysaccharides may be of considerable importance as regards the preservation of their functional activities. Thus Berenson (9), Bassiouni (7), and Meyer and coworkers (31, 32) have all used digestion with NaOH in combination with various proteolytic enzymes; such procedures would tend to break down naturally occurring complexes into smaller units. On the other hand, the mode of preparation of aortic mucopolysaccharide in the present report more closely resembles that utilized by Malawista and Schubert (29), and would seem to have the advantage, for functional studies, of the intact preservation of higher molecular weight polymers than that obtained by more drastic procedures. The technique employed here is in the nature

of an "enzymatic dissection" of the definitive tissue components of the artery wall with viokase, papain, and elastase, and the separation out of the mycopolysaccharides. The absence of hydroxyproline may be taken as evidence that this technique effectively removes contamination by other tissue components, as exemplified by the absence of collagen.

As pointed out, the final product seems to be primarily a protein-conjugated mucopolysaccharide. Its low sulphur content would further tend to indicate that this material contains little if any heparin, although the fact that it is protein-linked while heparin is not, would, as previously mentioned, diminish the difference in the sulphur content between the two substances. Like heparin, it has anticoagulant activity as well as the ability to inhibit the elastolytic activity of the enzyme elastase. While its sulphur content is even lower than that usually found in chondroitin sulfate, one cannot definitely exclude the possibility that it contains some of this material. The fact that other investigators (7, 9, 23, 31, 32) have obtained relatively high yields of chondroitin sulfate from arterial tissue and have demonstrated a relatively weak but definite anticoagulant activity of this substance would tend to support this possibility. Determination of glucosamine and galactosamine content might serve to indicate whether the mucopolysaccharide-protein complex contains heparin or chondroitin sulfate, but such analyses have not yet been carried out. Further, chondroitin sulfate (predominantly A) also has the ability to coat the elastic fiber and inhibit the elastolytic activity of elastase.

Peplar and Brandt (37), Hall (20), and Saxl (41) believe that the enzyme elastase has two components, one capable of solubilizing the mucopolysaccharide, designated a mucase, and the other capable of producing elastolysis of the elastin matrix. Hall (20), Banga and Schuler (5), Baló and associates (3, 4), and Saxl (41) have claimed that acid polysaccharides are liberated by the action of this enzyme on elastic fiber, and Saxl (41) states that this material is similar to chondroitin sulfuric acid. She postulates further that metachromatic polysaccharides exist either in the "pure" form, as chondroitin sulfuric acid or heparin, or are released by the action of elastase; they may then combine with the latter enzyme or a serum globulin fraction which contains an elastase inhibitor. In this concept it is also suggested that the globulin is required to inhibit the proteolytic portion of elastase and permit its mucase action to release mucopolysaccharide.

In the present experiments we have been able to show that the aortic polysaccharide, heparin, and chondroitin sulfate are capable of inhibiting the proteolytic activity of elastase. We have found no evidence for a mucase activity of this enzyme. In other experiments (47) it has been determined that elastase has a single specific activity which is proteolytic and which seems to be in the nature of an endopeptidase; it has a specificity for the bond which links the alpha nitrogen atom of glutamic acid, glutamine, aspartic acid, phenylalanine, or tyrosine to the protein molecule constituting the basic protein unit of the elastic fiber. Accordingly, it can also split various synthetic substrates, including carbobenzoxyglycyl-L-phenylalanine, and in this regard neither the aortic mucopolysaccharide nor heparin is effective as an inhibitor. It would thus seem that the inhibition by the latter substances is probably accomplished through a physical coating of the elastic fibers, which excludes the enzyme from access to susceptible chemical bonds. This concept is further supported by the microscopic observations showing the coating of naked fibers by both the mucopolysaccharide, chondroitin sulfate, and heparin. However, one cannot exclude the possibility that the latter substances enter into a chemical union with the envelope material of the elastic fiber and render it impermeable to elastase. It does seem definite, however, that this inhibition is accomplished by union of the polysaccharide with the substrate rather than with the enzyme.

Wood (46) has concluded that there is doubt as to whether the polysaccharide present in the elastic fiber plays an important role in its stability; this conclusion is based on the observation that the removal of the mucopolysaccharide from ox ligamentum nuchae has no influence on the elastic property of the fiber. While such chemical extraction may not seem to alter the physical properties of isolated elastic tissue, it may alter its susceptibility to enzymatic digestion. Much additional study is required before it can be concluded that the degenerative changes in the elastic elements in arteries are due to more than the continuing effects of physical forces, but certain studies seem to point in that direction. Baló and Banga

(2) have suggested that arteriosclerosis is the result of an imbalance of the elastase inhibitor reaction whereby the effective concentration of the enzyme is raised to limits at which degeneration of the elastic tissue is possible. They have shown that elastase is present in the human pancreas and diminishes with advancing age in this organ; it would thus seem that at the period of life when elastic tissue degeneration is most marked, the source of this enzyme is at a low ebb. On the other hand, Banga and associates (6) have reported an unstable elastase-inhibitor in human blood, the concentration of which seems to be inversely related to the degree of arteriosclerosis, and they have postulated that this inhibitor exists to prevent elastolysis in the artery wall by an enzyme such as elastase.

While the evidence is not extensive, it would seem that there may be a loss of mucopolysaccharides in arteries as well as other tissues with aging. Rinehart and associates (33, 38) have demonstrated that the earliest event in the process of intimal thickening and plaque formation is an increase in histochemically demonstrable mucopolysaccharides. However, as intimal plaques increase in size there is a progressive increase in collagen and a corresponding decrease in mucopolysaccharide. The process in the aorta seems to be not unlike that reported by Sobel and associates (42) in human dermis. These investigators have noted that with increasing age there is a tendency for the percentage of collagen to increase and the percentage of hexosamine to decrease and they have suggested that the hexosamine/collagen ratio of connective tissue may be used as a measure of age. Furthermore, Stidworthy and associates (43) have reported that the chondroitin sulfate content does not change significantly after maturity. Dyrbye and Kirk (16) have found that the yield of acid polysaccharides from aortas of older subjects is decidedly lower than that from aortas of either children or young adults. Moreover, the studies of Noble and associates (34) indicate that alterations in the physical state of mucopolysaccharides may also be an important factor in the genesis of arteriosclerosis. Such alterations in the mucopolysaccharides of arteries with aging could conceivably represent the local source of loss of elastase inhibitor required to validate the concept of Baló and Banga (3).

While it seems that the amino acid composition of the main mucopolysaccharide-protein complex obtained in the present study resembles that of elastin, it is also apparent that the molecular arrangement of these components is different, since this material is not attacked by elastase. The similarity in amino acid composition may, however, be significant in another regard. It conceivably may constitute a pool for the regeneration of elastic tissue. The existing potential in arteries for the reduplication and regeneration of elastic tissue elements has been reviewed by one of us (11), and it has been pointed out that the source material for this phenomenon has not, as yet, been identified. Such a pool would be comparable to that recognized as regards the relationship between procollagens and collagen as recently discussed by Orekhovitch and Shpikiter (36).

The anticoagulant ability of the aortic mucopolysaccharide, like chondroitin sulfate, has been found to be considerably weaker than heparin on a mg.-for-mg. basis, although the elastase inhibiting ability of the aortic mucopolysaccharide and heparin is almost equal. O'Brien (35) has recently concluded that the inhibition of early stages of blood coagulation by heparin may be due to the action of the latter on Christmas factor. His observations suggest that the depletion of an acidic mucopolysaccharide, like heparin, present in the intima of arteries, may make possible the inception of thrombus formation by permitting the action of Christmas factor. Astrup (1), in this regard, has pointed out that in a healthy organism fibrinolysis is in a dynamic equilibrium with the fibrin-depositing mechanisms, and each of these two is regulated by activating and inhibitory systems. The depletion in aging arteries of acid mucopolysaccharides could thus permit the deposition of fibrin, which Duguid (15) has pointed out may constitute an important mechanism in plaque formation.

A number of reports (12, 14, 18, 19, 26, 39, 41) have dealt with the ability of heparin and other mucopolysaccharides to clear the blood of absorbed fats, and it has also been pointed out (26, 39) that there is a relationship between the mechanisms which accomplish this effect and those capable of maintaining the fluidity of the blood. Furthermore, as with coagulation mechanisms, so also with lipid clearance, sensitive equilibria exist, and local alterations in the content of mucopolysaccharides, as with aging, may upset such mechanisms in the direction of

permitting the accumulation of lipids in arterial tissues. While lipid clearance from arteries by aortic mucopolysaccharide has not been investigated in the present study, attention is directed to this possibility in order to bring into perspective the full potential of this substance.

It should be recognized that the comparisons of the activities of heparin, chondroitin sulfate, and aortic mucopolysaccharide on a mg.-for-mg. basis, which have been made in this report, have only limited value. They serve to point out that these three substances have functional activities in common which have importance in retarding the arteriosclerotic process in arteries, and to a limited degree, their relative potencies as regards these activities. It seems likely that the aortic mucopolysaccharide contains both heparin and chondroitin sulfate, but it has not been determined whether other elements in the complex also contribute to these functions. However, since the aortic mucopolysaccharide has been studied in the form of a naturally occurring protein complex, while the other two were not protein linked, the concentrations of the active moieties were not comparable. On the other hand, until the nature of the protein to which they are linked in the natural state is known, it will not be possible to determine its importance as regards these activities.

## SUMMARY

A substance which seems to be in the nature of a mucopolysaccharide protein complex has been obtained from the aorta of cattle by a technique described as "enzymatic dissection." This material seems to have an amino acid composition resembling that of elastin and therefore may constitute a pool for substances required for the replacement of destroyed or degenerated elastic fiber. It further has the property of inhibiting elastolysis by elastase, and this seems to be accomplished by a union with substrate rather than with the enzyme. Certain observations suggest a physical coating of the elastic fiber and the exclusion of the enzyme from access to susceptible chemical bonds. This mucopolysaccharide exhibits an anticoagulant ability similar to heparin, although considerably less potent than the latter on a mg.-for-mg. basis. These properties are discussed with respect to their possible role in retarding degenerative processes in the walls of arteries.

## REFERENCES

1. Astrup, T.: The Biological Significance of Fibrinolysis. *Lancet, 271:* 565-568, 1956.
2. Baló, J., and Banga, I.: Elastolytic Activity of Pancreatic Extracts. *Biochem. J., 46:* 384-387, 1950.
3. Baló, J., and Banga, I.: Elastomucoproteinase and Collagen-Mucoproteinase, the Mucolytic Enzymes of the Pancreas. *Nature, 178:* 310-311, 1956.
4. Baló, J., Banga, I., and Schuler, D.: Vergleichende Untersuchungen über die Elastolyse der Gefässwand und Lig. Nuchae in histologischen Schnitten. *Acta morphol. Acad. Sci. Hungar., 4:* 141-148, 1954.
5. Banga, I., and Schuler, D.: Contribution to the Structure of Elastin with Special Reference to the Action of Elastase. *Acta physiol. Acad. Sci. Hungar., 4:* 13-24, 1953.
6. Banga, I., Schuler, D., and Laszlo, I.: Change of Elastase Inhibitor in the Blood of Ammonium Hydroxide Treated Rabbits. *Acta physiol. Acad. Sci. Hungar., 5:* 1-6, 1954.
7. Bassiouni, M.: The Estimation of Heparin and Similar Substances in Human Blood and Tissue Using a Combined Biological and Colorimetric Method with Paper Electrophoretic Studies. *J. Clin. Path., 7:* 330-335, 1954.
8. Belko, J., and Warren, R.: The Recalcification Time of Blood. *Arch. Surg., 76:* 210-218, 1958.
9. Berenson, G. S.: A Study of Acid Mucopolysaccharides of Bovine Aorta with the Aid of a Chromatographic Procedure for Separating Sulfated Mucopolysaccharides. *Biochem. Biophys. Acta, 28:* 176-183, 1958.
10. Blumenthal, G. H., and Blumenthal, H. T.: Structure and Composition of Aortic Elastic Tissue. *Fed. Proc., 17:* 429, 1958.
11. Blumenthal, H. T.: Response Potentials of Vascular Tissues and the Genesis of Arteriosclerosis. A Review. Part I. The Concept. *Geriatrics, 11:* 345-362, 1956.
12. Burstein, M., and Samaille, J.: Clarification of Lipemic Serum by Heparin in Vitro. *Compt. Rend. Acad. Sci. Paris, 241:* 664-665, 1955.
13. Chargaff, E., Bancroft, F. W., and Stanley-Brown, M.: Studies on Chemistry of Blood Coagulation. On Inhibition of Blood Clotting by Substances of High Molecular Weight. *J. Biol. Chem., 115:* 155-161, 1936.
14. Constantinides, P., Cairns, A., and Werner, A.: Antilipemic Activity of Sulfated Polysaccharides. *Arch. Internat. Pharmacodyn., 99:* 334-345, 1954.
15. Duguid, J. B.: Thrombosis as a Factor in the Pathogenesis of Coronary Atherosclerois. *J. Path. & Bact., 58:* 207-212, 1946.
16. Dyrbye, M., and Kirk, J. E.: Mucopolysaccharides of Human Arterial Tissue. I. Isolation of Mucopolysacharide Material. *J. Gerontol., 12:* 20-22, 1957.
17. Einbinder, J., and Schubert, M.: Separation of Chondroitin Sulfate from Cartilage. *J. Biol. Chem., 185:* 725-730, 1950.
18. Gillman, T., Hathorn, M., and Penn, J.: Lipaemia Clearing Action of Sulphated Animal Hyaluronate. *Nature, 177:* 894-895, 1956.

19. Hahn, P. F.: Abolishment of Alimentary Lipemia Following Injection of Heparin. *Science, 98:* 19-20, 1943.

20. Hall, D. A.: The Complex Nature of the Enzyme Elastase. *Arch. Biochem. & Biophys., 67:* 366-377, 1957.

21. Hall, D. A., Reed, R., and Tunbridge, R. E.: Structure of Elastic Tissue. *Nature, 170:* 264-266, 1952.

22. Hall, D. A., Reed, R., and Tunbridge, R. E.: Electron Microscopic Studies of Elastic Tissue. *Exper. Cell Res., 8:* 35-48, 1955.

23. Jorpes, J. E.: *Heparin in the Treatment of Thrombosis.* Oxford University Press, New York, 1946.

24. Lansing, A. I., Ramasarma, G. B., Rosenthal, T. B., and Alex, M.: Changes with Age in Amino Acid Composition of Arterial Elastin. *Proc. Soc. Exper. Biol. & Med., 76:* 714-717, 1951.

25. Lansing, A. I., Rosenthal, T. B., Alex, M., and Dempsey, E. W.: The Structure and Chemical Characterization of Elastin Fibers as Revealed by Elastase and by Electron Microscopy. *Anat. Rec., 114:* 555-575, 1952.

26. Leading Article. The Clearing System for Blood Fats. *Lancet, 271:* 930-931, 1956.

27. Lowry, O. H., Gilligan, D. R., and Katersky,, E. M.: The Determination of Collagen and Elastin in Tissues, with Results Obtained in Various Normal Tissues from Different Species. *J. Biol. Chem., 39:* 795-804, 1941.

28. Lowry, O. H., Rosebrough, N. J., Fair, A. L., and Randall, R. J.: Protein Measurement with the Folin Phenol Reagent. *J. Biol. Chem., 193:* 265-275, 1951.

29. Malawista, I., and Schubert, M.: Chondromucoprotein: New Extraction Method and Alkaline Degradation. *J. Biol. Chem., 230:* 535-544, 1958.

30. Marbet, R., and Winterstein, A.: Mucopolysaccharides with Special Reference to Heparin. *Experimentia, 8:* 41-44, 1952.

31. Meyer, K., Davidson, E., Linker, A., and Hoffman, P.: The Acid Mucopolysaccharides of Connective Tissue. *Biochem. Biophys. Acta, 21:* 506-518, 1956.

32. Meyer, K., and Rapport, M. M.: The Mucopolysaccharides of the Ground Substance. *Science, 113:* 596-599, 1951.

33. Moon, H. D., and Rinehart, J. F.: Histogenesis of Coronary Arteriosclerosis. *Circulation, 6:* 481-488, 1952.

34. Noble, N. L., Boucek, R. J., and Kao, K-Y. T.: Biochemical Observations of Human Atheromatosis. Analysis of Aortic Intima. *Circulation, 15:* 366-372, 1957.

35. O'Brien, J. R.: Heparin and Christmas Factor. *Nature, 181:* 1801-1802, 1958.

36. Orekhovitch, V. N., and Shpikiter, V. O.: Procollagens. *Science, 127:* 1371-1375, 1958.

37. Pepler, W. J., and Brandt, F. A.: The Nature of the Elastolytic Enzyme and the Structure of Elastin. *Brit. J. Exper. Path., 35:* 41-45, 1954.

38. Rinehart, J. F., and Greenberg, L. D.: Pathogenesis of Experimental Arteriosclerosis in Pyridoxine Deficiency, with Notes on Similarity to Human Arteriosclerosis. *Arch. Path., 51:* 12-18, 1951.

39. Robinson, D. S., and French, J. E.: The Heparin Clearing Reaction and Fat Transport. *Quart. J. Exper. Physiol., 42:* 151-163, 1957.

40. Sachar, L. A., Winter, K. K., Sicher, N., and Frankel, S.: Photometric Method for Estimation of Elastase Activity. *Proc. Soc. Exper. Biol. & Med., 90:* 323-326, 1955.

41. Saxl, H.: The Physiological Significance of the Reaction Between Elastin and Elastomucase in Relation to the Production of "Clearing Factor." *Gerontologia, 1:* 142-163, 1957.

42. Sobel, H., Gabay, S., Wright, E. T., Lichtenstein, I., and Nelson, N. H.: The Influence of Age Upon Hexosamine-Collagen Ratio of Dermal Biopsies from Man. *J. Gerontol., 13:* 128-131, 1958.

43. Stidworthy, G., Masters, Y. F., and Shetlar, M. R.: The Effect of Aging on Mucopolysaccharide Composition of Human Costal Cartilage as Measured by Hexosamine and Uronic Acid Content. *J. Gerontol., 13:* 10-13, 1958.

44. Troll, W., and Connan, R. K.: A Modified Photometric Ninhydrin Method for the Analysis of Amino and Imino Acids. *J. Biol. Chem., 200:* 803-811, 1953.

45. Troll, W., and Lindeley, J.: A Photometric Method for the Determination of Proline. *J. Biol. Chem., 215:* 655-660, 1955.

46. Wood, G. C.: The Stabilization of Elastin by a Polysaccharide (Abstract). *Biochem. J., 55:* XXIV, 1953.

47. Yu, S. Y., Blumenthal, G. H., and Blumenthal, H. T.: Proteolytic Specificity of Pancreatic Elastase. *Fed. Proc., 17:* 341, 1958.

# SWIMMING SPEED OF THE ALBINO RAT:

## I. Age and Sex Differences

JAMES E. BIRREN, Ph.D.* AND HARRY KAY, Ph.D.†

*(From the National Institute of Mental Health, Bethesda, and the University of Oxford, Oxford)*

Slowing in response speed has been shown to be one of the key changes in aging. This has been shown for both men and animals and in a variety of tasks (1). At this stage of inquiry it seems important to distinguish age changes in speed of two kinds of tasks: (a) those involving a quick response to an external stimulus of random onset, and (b) serial tasks where a sequence of movements are programmed in advance. In the first case, speed is to a considerable extent determined by the time required to initiate the response, whereas in the second case the influence of "initiation" and choice would be minimal. The two kinds of task need not show the same amount of change with age; also the performance of the same organism need not be highly correlated on the two classes of task.

The reaction time of the rat to a random stimulus has been shown to slow with age (2). This fact led to the purpose of the present study which was to examine the performance of rats of different ages on a serial task, swimming, which would seem to differ in many essential ways from a startle reaction time. Singleton (4), for example, has pointed out that decision points in a sequence of movements show greater change in speed with age than does movement speed itself. In addition to its systematic usefulness in contrasting speed changes in different types of task, swimming also seemed to be a potentially useful behavior with which to study other variables in relation to aging, such as fatigue and drugs.

### METHOD

*Apparatus:* The tank used in swimming the rats was a long metal trough, deep enough so that the animal could not touch bottom, wide enough to prevent straddling, and with sufficiently high sides to prevent the rat from jumping out. The dimensions of the tank were 5″W × 15″D × 13′10″L; water level 9″D. The distance the rat swam was 11′6″, allowing for the projection of the ramp into the water and the starting area. The inside of the tank was painted black to avoid possible distracting reflections. At the starting end an electric lamp was placed behind a glass window (2½″ dia.) to give a clear orienting signal for the animal, i.e., to swim away from the light toward the ramp end. Also, above the window was placed an air jet to discourage initial exploration of the starting end and to establish the swimming pattern as soon as the animal was placed in the water.

*Subjects:* A total of 109 albino rats of the Sprague-Dawley strain was used. The rats were from the colony of the Section on Aging maintained from weanling age throughout the life span under constant conditions of diet, caging, and handling.

*Procedure:* The rat was placed by hand in the starting end of the tank. As soon as his hind quarters passed a starting line, the experimenter started an electric timer, which was stopped when the front paws of the rat touched the ramp. This was recorded to the nearest 0.1 sec. The rat was removed from the ramp and placed in an adjacent "drying-off" cage until the next swimming trial. A one-minute rest interval separated trials. Five trials constituted a session. A minimum rest of one hour was allowed between sessions.

Trials where the animal hesitated were not included in the results; only trials where the rat swam straight to the ramp without hesitation were included in computations. In general it seemed as though each rat would make an exploratory swim to see if there were another escape, e.g., return to the starting end, attempt to climb the walls, or circle in the middle. Once having explored the tank they swam acceptably, and no animals had to be eliminated in the present group.

*Reliability:* Two measures of the rat's performance were analyzed, fastest swimming time

Submitted for publication July 21, 1958.

* Section on Aging, Laboratory of Psychology, National Institute of Mental Health, National Institutes of Health, Public Health Service, Bethesda, Maryland. Grateful acknowledgment is given for the suggestions and assistance of Conan Kornetsky, Jack Botwinick, Joel Garbus, and Samuel Umberger.

† Visiting Scientist, National Institute of Mental Health, 1957-1958.

and median swimming time. In the first statistic one is interested in the maximum performance of the rat and in the second a measure of "average" performance. The median is here preferred to the mean because of the possibility of an undue effect on the mean of occasional slow or erratic trials.

The reliability of the two measures were determined by a comparison of results obtained on 39 rats of mixed age and sex for two sessions of 5 trials each. The fastest swimming times of the two runs correlated highly, i.e., $r = 0.90$, $\sigma$ est $= 1.0$ sec. The median swimming time correlated $r = 0.92$, $\sigma$ est $= 1.2$ sec.

*Practice effects:* Although the above results on reliability suggest that individual measurements of speed are stable, there is some evidence of practice effects between the first two sessions. Little difference, however, appears between results of session 2 and 3 (table 1).

A group of 70 rats was given two swimming sessions 13 days apart. The mean fastest swimming times were 9.8 and 9.9 sec.; $\sigma = 1.3$ and 1.4, respectively. The means of the individual median swimming times were 11.2 and 10.7; $\sigma = 1.9$ and 2.0, respectively. These data suggest that there is considerable stability in the nature of distributions of measurements on two different days.

*Temperature:* The temperature of the water in which the rat swims might be expected to affect swimming speed. With the water at room temperature (23 C.), rats seem less motivated to swim directly to the exit end of the tank, giving a poor basis for measuring maximum performance.

A group of 39 rats, mixed age and sex, was given 5 trials at 20 C., yielding a mean fastest time of 10.6, $\sigma = 1.4$, and mean of the median performance 11.4, $\sigma = 1.5$. These values lie clearly within the ranges reported in table 1 for 17-18 C. Thus temperature variations of one or two degrees in the range of 16-20 C. were not crucial.

TABLE 1. PRACTICE EFFECTS ON SWIMMING TIME. Each session consists of 5 consecutive trials separated by one-minute rest intervals. Time is reported in seconds, N=39, (17-18 C. water temperature).

| Session | | 1 | 2 | 3 |
|---|---|---|---|---|
| Fastest Time | Mean | 10.9 | 10.1 | 10.2 |
| | $\sigma$ | 2.4 | 1.9 | 1.3 |
| Median Time | Mean | 12.3 | 11.6 | 11.5 |
| | $\sigma$ | 3.1 | 3.1 | 2.6 |

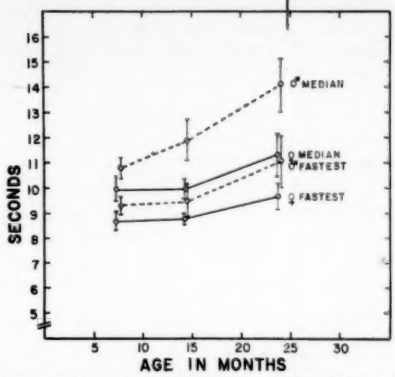


Fig. 1. Swimming time of the albino rat as a function of age and sex. Time is reported in seconds to swim 11′ 6″. Measurements were based on 109 rats of different age and sex and were taken of the fastest time and the median time of 5 trials. Vertical lines are plotted as ± one standard deviation about the mean.

*Pre-wetting:* Some initial buoyancy might be expected from air trapped in dry fur, thus affecting the early swimming trials. It might also be considered that an old animal would show a different effect than a young one because of thinner fur. An attempt was made to see if this was a significant factor by wetting a group of animals before their first swimming trial, but this had no apparent effect on their performance.

## RESULTS

A total of 109 rats of both sexes and different ages was given 5 swimming trials on two different days. Results indicate that old rats are slower than young rats in both their fastest and median swimming time. The difference between 7-10 months and 22-27 months in fastest swimming time was about 1 sec., or 12%, for females and 1.4 sec., 14%, for males. Comparable differences in median swimming time were 1.8 sec., 20%, for females and 3.3 sec., 30%, for males (fig. 1 and table 2). These age differences are all statistically significant beyond the .01 level.

In all instances the females were faster swimmers than the males. The sex difference approached the size of the age difference. Thus the age difference in median swimming time of females was 1.4 sec., whereas the sex difference was 2.7 sec. for old animals, and 1.3 sec. for young animals. All differences are significant beyond the 1% level.

TABLE 2. AGE AND SEX DIFFERENCES IN SWIMMING TIME.
Data were obtained from 5-trial sessions on two days.

| | | A | B | C | $\bar{A} - \bar{C}$ | |
|---|---|---|---|---|---|---|
| Age in Months | | 7-10 | 12-17 | 22-27 | | |
| | | N=20 | N=15 | N=20 | | |
| Fastest Time | Mean | 8.6 | 8.8 | 9.7 | 1.1 | t=4.5 |
| | $\sigma$ | 0.84 | 0.57 | 1.12 | | |
| Female | $\sigma_{\bar{x}}$ | 0.19 | 0.15 | 0.26 | | |
| Median Time | Mean | 10.0 | 9.9 | 11.4 | 1.4 | t=3.01 |
| | $\sigma$ | 1.09 | 0.81 | 1.66 | | |
| | $\sigma_{\bar{x}}$ | 0.25 | 0.22 | 0.38 | | |
| | | N=20 | N=15 | N=19 | | |
| Fastest Time | Mean | 9.2 | 9.5 | 11.0 | 1.8 | t=3.62 |
| | $\sigma$ | 0.70 | 1.58 | 1.99 | | |
| Male | $\sigma_{\bar{x}}$ | 0.16 | 0.42 | 0.47 | | |
| Median Time | | 10.8 | 11.9 | 14.1 | 3.3 | t=6.00 |
| | $\sigma$ | 0.87 | 1.59 | 2.15 | | |
| | $\sigma_{\bar{x}}$ | 0.20 | 0.42 | 0.51 | | |

All sex diffs. $P < .01$.

Body weight might affect age differences in swimming speed if very young rats were compared with fully mature ones. In the present study the youngest rats were 7 months old, an age when they have almost attained full adult size. There is thus very little change in body weight in the age range covered in this study (table 3). Since swimming speed is changing significantly during the period wherein body weight remains relatively stable, body weight cannot be the factor responsible for the age change in swimming speed within the sexes. This is further substantiated by examining results on a group of 10 old males weighed just prior to swimming. The mean fastest swimming time was 10.1 sec. for the heaviest 5 animals and 10.4 sec. for the lightest 5; corresponding median times were 12.8 and 13.3. The present data do not provide evidence of the influence of weight differences as a basis for faster swimming speed of the females.

TABLE 3. BODY WEIGHT IN GRAMS.

| | | A | B | C |
|---|---|---|---|---|
| Age in Months | | 7-10 | 12-17 | 22-27 |
| | | N=10 | N=15 | N=10 |
| | Mean | 273.0 | 303.0 | 313.5 |
| Female | $\sigma$ | 25.4 | 40.6 | 30.0 |
| | $\sigma_{\bar{x}}$ | 8.5 | 10.9 | 10.0 |
| | | N=10 | N=15 | N=10 |
| | Mean | 432.5 | 483.3 | 474.0 |
| Male | $\sigma$ | 60.4 | 67.0 | 93.8 |
| | $\sigma_{\bar{x}}$ | 20.1 | 17.9 | 31.3 |

## DISCUSSION

The present study showed less of an age change in a continuous task, swimming, than did a previous study of startle reaction time (2). In the present investigation the age differences (7-10 to 22-27 months) were 12 and 14%, respectively, for females and males in fastest swimming time and 20 and 30% for median swimming time. In the previous startle reaction time study, age differences of approximately 100% were found for auditory startle reaction time and about 29% for shock reaction time. In general a comparison of the results of these studies indicates a greater slowing of response with age in the sudden startle situation than in the speed of a continuous task, perhaps reflecting a change in "basal response readiness." Human studies have also suggested the possibility of an age change in both response readiness as well as in the fastest possible reaction time (3).

Several points should be considered in selecting an experimental swimming sequence, such as the number of trials and number of days, in relation to some desired level of accuracy. For establishing differences between age and sex groups, in general, the results secured in a single 5-trial session are sufficient. If, however, more stable results are desired to represent a single animal, two factors operate somewhat against each other; fatigue effect and the practice effect of an increased number of trials. It is often found with older animals that the initial swim in a group of 5 trials is the fastest, successive trials becoming progressively slower. In contrast to the fatigue effect, it is important to group a number of trials to establish a pattern or rhythm of swimming, i.e., the animal's doing it sufficiently often and close enough together to develop a habit of swimming directly. In the present study this was done by having 5 trials with one-minute rests between trials. If additional sessions are to be used to achieve greater accuracy, a rest period has to be allowed between sessions, e.g., a half-hour. It is not possible from the correlations obtained in the

present study to secure a direct estimate of the reliability of swimming times based on 2 sessions of 5 trials on 2 successive days, but it might be expected to yield standard errors of measurement of about 0.2 sec. in an individual rat. This is a rough approximation based on an estimation of expanding 5 trials to 20, with the previously obtained correlations.

If only young animals are studied a greater number of trials can be used per session, without marked fatigue effects. Incorporation of a drug or other variables into an experiment on swimming time might yield a mixed effect of fatigue and minimum swimming time, but the fatigue curve itself might be analyzed if sufficient trials are used.

## SUMMARY

The purpose of this study was to observe possible age differences in the speed of a continuous task, swimming, in the albino rat. Previous work has indicated a slowing with age in the startle reaction time and it seemed of systematic interest to contrast performance for the two types of task.

The apparatus used in this study was a long narrow tank (5″W × 15″D × 13′10″L; water level 9″D). The rat was placed at the starting end and was timed to swim 11′6″ to an exit ramp. Five swimming trials were given each session; one-minute rest intervals were allowed between trials. Both the fastest time and the median time for each animal were used in the analysis of results.

Statistically significant age differences in swimming speed were found for both males and females. In all instances the females were faster swimmers. Differences between rats 7-10 and 22-27 months were 12% for females and 14% for males; comparable differences in median swimming time were 20% for females and 30% for males.

The simplicity of the method in obtaining a quick and reliable measurement of speed of performance makes swimming speed a useful method of exploring age differences in speed, fatigue, and possible drug effects.

## REFERENCES

1. Birren, J. E.: Age Changes in Speed of Simple Response and Perception and Their Significance for Complex Behavior. In: *Old Age in the Modern World.* E. & S. Livingstone, London 1955, pp. 235-247.
2. Birren, J. E.: Age Differences in Startle Reaction Time of the Rat to Noise and Electric Shock. *J. Gerontol., 10:* 437-440, 1955.
3. Botwinick, J., Brinley, J. F., and Birren, J. E.: Set in Relation to Age. *J. Gerontol., 12:* 300-305, 1957.
4. Singleton, W. T.: Age and Performance Timing on Simple Skills. In: *Old Age in the Modern World.* E. & S. Livingstone, London 1955, pp. 221-231.

# SWIMMING SPEED OF THE ALBINO RAT:

## II. Fatigue, Practice, and Drug Effects on Age and Sex Differences

HARRY KAY, Ph.D.,* AND JAMES E. BIRREN, Ph.D.†

*(From the University of Oxford, Oxford, and the National Institute of Mental Health, Bethesda)*

Having demonstrated that there were differences in the initial swimming speeds of old and young rats (1), it was pertinent to examine some of the variables which might influence these performances. While the older rats were slower, it was possible that this slowness conserved their strengths with the result that they would not fatigue so quickly. It was also relevant to find out whether the performances of the age groups would be differentially influenced by practice, since it was not known whether the rates of improvement would be such that initial age differences would be wiped out or accentuated. The present study therefore attempted to answer the following questions: (a) What are the effects of fatigue upon the swimming speeds of rats of different age and sex? (b) What are the effects of continued practice upon the above performances?

A preliminary attempt was also made to use certain drugs as analytic tools. If the action of such stimulants was localized, e.g., to some particular part of the central nervous system, then a useful indication might be given as to where lay the weakness in the older organism. Such an argument, while theoretically unexceptional, is of course naive in its hopeful conception of a strictly local action for a particular drug. Nevertheless, it was considered worthwhile to make a tentative assay with some drugs, for if any were identified which differentially influenced the older animals' speed of swimming and their susceptibility to fatigue, this would not only be of practical use but further attempts could then be made to localize the mechanisms involved.

### A. FATIGUE EFFECTS

*Apparatus:* The tank was identical with that described in the previous study (1). It measured 5″W × 15″D × 13′10″L; water level 9″D. Water temperature was maintained at 17-18 C. Time to swim 11′6″ between the start and exit ramp was recorded to the nearest 0.1 sec.

*Subjects:* 40 albino rats of the Sprague-Dawley strain were divided equally into 4 groups: two old groups, one male and one female, aged between 23 and 27 months, and two young groups, male and female, aged between 7 and 8 months.

*Procedure: Initial Swimming Performances:* On the first day the animals were given 3 blocks of 5 trials each. The blocks of trials were spaced one hour apart, and the 5 trials within a block were swum one minute apart. From these data the basic swimming time of each animal was recorded.

*Fatigue Trials:* One day later the fatigue trials were swum. A rat was placed in the tank at the starting point. When it had swum the 11′ 6″ to the other end it was immediately picked out and returned to the starting point, and the whole cycle was repeated. The time between completing one trial and beginning the next was kept as constant as possible and was of the order of 10 sec., with a variation of ±2 sec. The time for each trial was recorded and the rat completed 30 trials or was pulled out when either it was no longer able to swim or its time on any trial exceeded 60 sec. Such a time limit represented approximately a 6-fold increase in swimming time over the animal's basic performance.

*Recovery Trials:* After the 30 fatigue trials, each animal was rested 5 minutes and then given 5 further trials under exactly the same conditions as the fatigue tests. This completed the experimental procedure.

*Results:* Old rats were found to be more susceptible to fatigue, as indicated by the results presented in table 1 and figure 1. In the table the swimming times are the group means of each individual's *fastest* performance within the particular block of 5 trials. Standard deviations are given but it should be pointed out that the times and the measure of scatter are misleadingly small in the case of the older males for their last three blocks of trials, 16-20, 21-25,

Submitted for publication July 21, 1958.

* Visiting Scientist, National Institute of Mental Health, 1957-1958.

† Section on Aging, Laboratory of Psychology, National Institute of Mental Health, National Institutes of Health, Public Health Service, U. S. Department of Health, Education and Welfare, Bethesda, Maryland.

and 26-30. This is because several of the rats in this group were unable to complete these trials and the artificial ceiling time of 60 sec. was imposed. Despite this upper limit it was believed worthwhile to present the table in this form since the remaining group means are representative of the animals' times as can be seen from the standard deviations. Figure 1 is based on *median* values. For each block of 5 trials a rat's median time was taken, and each point on the figure is based upon the group's median of the individual medians. This overcame the statistical difficulty of animals not completing their trials.

It will be observed from figure 1 that at the end of 30 trials the swimming time for all groups had increased. This was true for every animal, but the rate of decline in performance was not the same in the groups and can best be considered by treating each separately.

Initially the young females were the fastest swimmers and they remained so throughout the fatigue trials, showing little decline during the first 20 trials. Thereafter, they did swim more slowly and for the last 5 trials their times were 50% longer than their initial performances (see table 1). The young males on their first trials swam slightly slower than the young females and already by the 20th trial there was a 33% increase in their performance times. This was further accentuated during the last 10 trials where the final time increase was 72%.

The speed of the old females declined steadily throughout all their trials, showing a 50% time increase between the 15th and 20th trial. During the last 5 trials this trend was accentuated, reaching an increase of 150%, but this was in part due to the extreme slowness of two of the 10 animals which became exhausted.

The old males' performances were strikingly different from those of the other groups. Not only were they slower swimmers initially than the other animals, but their speeds began to decline at a very early stage, so much so that it was of the order of 50% within the first 10 trials. Thereafter several animals became too fatigued to complete their trials; one failed between trials 10-15, two more between 16-20, one more between 21-25, and one more between 26-30, making a total of 5 failures out of 10. Thus half of the old males were too fatigued to complete their trials, whereas only one other animal (an old female on the 26th trial) out of the 30 in the other groups failed in this way. Of the 5 old males which did complete, one showed a 200% increase in swimming time and the other 4 increases of the order of 300%. After completing over 20 trials the old females began to show something of

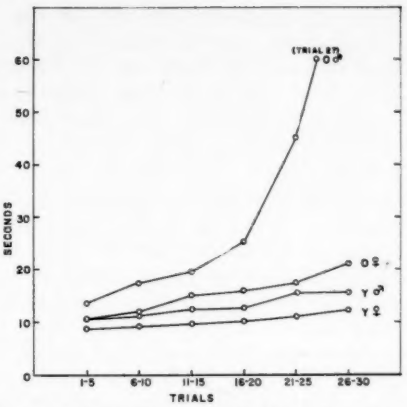


Fig. 1. Fatigue effect on swimming times. Curves are drawn through median values for each block of 5 swimming trials. Swimming time is given in seconds to swim 11½ feet. A total of 40 rats was used; 10 in each sex and age group.

TABLE 1. MEAN FASTEST SWIMMING TIMES BY AGE, SEX, AND TRIALS. TIME IN SECONDS TO SWIM 11.5 FEET.

| Group | | Initial Performance Times | Trials | | | | | | Recovery Trials | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1-5 | 6-10 | 11-15 | 16-20 | 21-25 | 26-30 | 1 | 2 | 3 | 4 | 5 |
| Young Females | Times | 8.9 | 8.5 | 8.7 | 9.2 | 9.5 | 10.5 | 12.1 | 11.6 | 10.2 | 11.5 | 12.5 | 13.5 |
| N = 10 | S.D. | 1.03 | 1.22 | 1.14 | 1.14 | 1.14 | 1.73 | 2.60 | 2.13 | 1.43 | 1.57 | 2.06 | 2.84 |
| Young Males | Times | 9.1 | 9.5 | 10.7 | 11.5 | 12.4 | 14.5 | 16.4 | 11.7 | 12.8 | 17.7 | 20.8 | 23.3 |
| N = 10 | S.D. | 1.21 | 1.69 | 1.00 | 1.50 | 1.51 | 2.54 | 5.01 | 1.21 | 2.58 | 11.7 | 13.6 | 13.9 |
| Old Females | Times | 9.9 | 9.7 | 11.7 | 13.3 | 15.7 | 17.6 | 25.2 | 13.8 | 20.4 | 25.5 | 32.6 | 36.3 |
| N = 10 | S.D. | 1.22 | 1.70 | 2.79 | 2.39 | 2.30 | 4.24 | 15.0 | 3.09 | 13.4 | 13.0 | 16.5 | 17.3 |
| Old Males | Times | 11.9 | 11.3 | 16.2 | 25.4 | 32.2* | 39.4* | 44.6* | 21.7 | 34.7 | 50.5 | — | — |
| N = 10 | S.D. | 2.12 | 2.77 | 3.39 | 15.5 | 18.6* | 17.9* | 15.6* | 13.2 | 17.7 | 12.7 | — | — |

* Contained animals which failed to swim the tank in 60 sec. or less.

the same decline in performance as the old males had shown after 10 trials while the two young groups over 30 trials had never reached the point of a marked decline. These results would seem to indicate then that the old males were swimming much nearer to their physiological limits. This feature was further brought out in the recovery trials.

*Recovery Trials:* The performances during the recovery trials were closely related to those during the fatigue trials and tend to accentuate the group differences which had already been observed (table 1, recovery trials). The young females were slower than on their initial trials but their times during the 5 recovery trials only increased from 11.6 to 13.5 sec. making them much the fastest group on the fifth trial. The young males seemed to have recovered equally as the young females and on their first trial were swimming at about the same rate, 11.7 to 11.6 sec., but as a group they fatigued much faster and by the fifth trial their mean time was 23.3 sec.

The two old groups declined rapidly. The old females had recovered sufficiently to swim their first trial in 13.8 sec. but by the third trial were as slow as they were at the end of the fatigue trials (25 sec.). The old males were much the slowest performers. As a group they had only recovered sufficiently to swim their first trial in 21.7 sec. and by the third trial 5 of the 10 animals could not swim the trial in 60 sec. At the fifth trial only one animal completed the distance. This is in marked contrast to the younger groups in which no animal failed and to the old females where only one did not complete. Apparently the fatigue developed in this study is cumulative and is not dissipated in so short a period as 5 minutes of rest.

## DISCUSSION

*Differences between age groups:* From these results it is clear that when animals of the same sex are being compared, age differences in their performances are pronounced, particularly for the males. Old males fatigued quickly though their initial times were much the longest of all the groups. Apparently even when swimming at this slower rate they were prone to become exhausted; it would seem that their reserve of strength was less. This point is of interest since the older organism's slower performance is often thought of as a husbanding of resources in the nature of an adaptive strategy to meet continuous environmental demands. In so far as these old males were concerned their slower performance was a harsh necessity, representing their maximum possible rate which soon exhausted them. This was not so with the young males who dropped their rate of swimming but succeeded in completing the task.

It will be observed how markedly the effects of fatigue accentuated the differences between the age groups. The young males and the old females, which were almost identical in times on the early trials, were markedly different on the latter. This is clearly seen in the rank order positions of the total 40 animals. The two groups of young males and old females have nearly the same mean rank order on the first 5 trials, 20.0 and 19.4 respectively, but after 25 trials the young males have a mean position of 15.2 while the old females have fallen to 24.1. It is of note that in ranking the fastest swimmers for the last 5 trials, the first 15 animals were all in the two young groups, and the first 7 of these 15 were females.

*Differences between sexes:* The differences in the swimming time of the two sexes were also pronounced, particularly when comparing the two older groups. The young females swam fastest on the initial trials and were able to maintain this rate for more trials, so that at all stages they were superior to the younger males. The old females who, as noted above, were equal to the young males on the first trials did fatigue more, but were markedly better than the old males at all stages.

It is not often found in mammals that the female is the faster or stronger member of a species, and the reason for the superiority of the female in this swimming task, both initially and over 30 trials, is puzzling. An obvious sex difference is in size and weight. The males were larger and their weights ranged from 400 to 500 Gm. whereas the females were only 260 to 320 Gm. Crude attempts were made to measure the volume of the rats—by the amount of water they displaced—and the results did not suggest there was any marked difference in the specific gravity of the two sexes. The old males had less fur than the females, but this difference did not hold for the young animals, nor would there seem to be any difference in the body-shape of the two sexes which would favor the females' swimming. As subjective

evidence it may be pointed out that to the experimenters who handled the rats the results were not surprising and did not seem to be an artifact of the swimming task. In every behavioral respect the females were more active and vigorous, and this was true for many groups of animals selected from the colony. It seemed, therefore, that in this strain the superior swimming of the females reflected a superior physical ability. It might also be mentioned that the average length of life of these rats is about 3-4 months longer for the females, agreeing with published reports (2, p. 168).

## B. PRACTICE AND DRUG EFFECTS

*Subjects:* 24 rats from the same colony were divided into 4 groups; the old males and old females were between 23 and 24 months of age, and the young males and females were 11 months. The old and young animals of the same sex were matched as nearly as possible for body weights, the males averaging 430 Gm. and the females 300 Gm.

*Procedure:* The same water tank was used as in the previous study and the water temperature was maintained at 17-18 C. The procedure was slightly amended. It was intended to swim the rats repeatedly to see how far their performances would be influenced by practice and the effects of drugs. Because 30 trials had proved exhausting for the old rats, it was thought that this would be too many trials to give the animals on many consecutive days. The former fatigue curves were examined and it was decided to swim the rats for 15 trials on each practice day, this number of trials indicating some degree of fatigue in the sample to date.

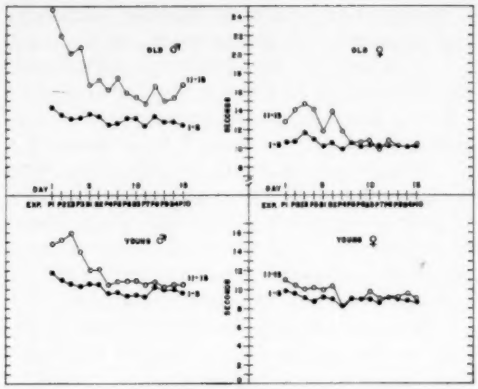


Fig. 2. The effects of practice upon swimming times. Curves are drawn through the median values for the first and last blocks of trials on successive practice days.

Accordingly, over a period of three weeks the rats were swum on 12 days for 15 trials each. At the end of this period their performance had so materially improved that for the three occasions in the last week of the experiment they were again made to swim for 30 trials. In all the experiment lasted one month.

TABLE 2. MEAN SWIMMING TIMES IN SECONDS BASED UPON INDIVIDUAL MEDIAN TIMES FOR TRIALS 1-5, 6-10, 11-15.

| Day | Condition | All Animals | | | Old Males | | | Old Females | | | Young Males | | | Young Females | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trials | | | Trials | | | Trials | | | Trials | | | Trials | | |
| | | 1-5 | 6-10 | 11-15 | 1-5 | 6-10 | 11-15 | 1-5 | 6-10 | 11-15 | 1-5 | 6-10 | 11-15 | 1-5 | 6-10 | 11-15 |
| 1 | P1 (Placebo) | 11.7 | 13.7 | 16.0 | 14.3 | 18.3 | 24.7 | 10.7 | 11.8 | 12.8 | 11.7 | 13.3 | 14.8 | 9.9 | 11.0 | 11.1 |
| 2 | P2 | 11.3 | 13.5 | 15.5 | 13.5 | 18.1 | 21.9 | 10.8 | 11.9 | 14.1 | 11.0 | 13.4 | 15.3 | 9.7 | 10.4 | 10.5 |
| 3 | Es. (Eserine) | 11.1 | 13.7 | 15.3 | 13.1 | 17.3 | 20.1 | 11.6 | 12.9 | 14.8 | 10.6 | 13.1 | 16.0 | 9.3 | 9.6 | 10.1 |
| 4 | P3 | 10.8 | 12.9 | 14.8 | 13.2 | 16.8 | 20.7 | 11.1 | 12.6 | 14.2 | 10.4 | 12.9 | 13.9 | 8.7 | 9.6 | 10.2 |
| 5 | B1 (Benzedrine) | 11.0 | 12.5 | 12.7 | 13.7 | 16.2 | 16.7 | 10.2 | 11.7 | 11.9 | 10.7 | 12.0 | 12.0 | 9.4 | 10.0 | 10.0 |
| 6 | B2 | 10.9 | 13.2 | 13.5 | 13.4 | 17.0 | 17.2 | 10.6 | 13.9 | 14.0 | 10.5 | 11.7 | 12.2 | 9.1 | 10.3 | 10.5 |
| 7 | P4 | 10.0 | 11.1 | 11.8 | 12.4 | 14.9 | 16.2 | 9.9 | 10.6 | 11.9 | 9.6 | 10.2 | 10.6 | 8.2 | 8.6 | 8.4 |
| 8 | P5 | 10.5 | 11.6 | 12.0 | 12.6 | 16.4 | 17.4 | 10.7 | 10.2 | 10.5 | 9.8 | 10.3 | 10.9 | 9.1 | 9.6 | 9.1 |
| 9 | P6 | 10.4 | 11.1 | 11.6 | 13.2 | 14.7 | 15.8 | 10.2 | 10.4 | 10.7 | 9.4 | 10.1 | 10.9 | 9.0 | 9.4 | 9.1 |
| 10 | B3 | 10.5 | 11.6 | 11.8 | 13.1 | 14.9 | 15.3 | 10.4 | 11.0 | 10.9 | 9.5 | 10.6 | 11.0 | 9.1 | 9.9 | 9.8 |
| 11 | P7 | 10.1 | 11.0 | 11.1 | 12.4 | 15.4 | 14.7 | 10.1 | 9.9 | 9.9 | 9.3 | 9.9 | 10.6 | 8.6 | 9.0 | 9.3 |
| 12 | P8 | 10.8 | 11.4 | 11.9 | 13.4 | 15.3 | 16.5 | 10.3 | 10.2 | 10.9 | 10.3 | 10.5 | 10.9 | 9.4 | 9.7 | 9.2 |
| *13 | P9 | 10.6 | 11.3 | 11.3 | 12.7 | 14.8 | 15.0 | 10.6 | 10.4 | 10.4 | 10.0 | 10.2 | 10.2 | 9.2 | 9.7 | 9.4 |
| *14 | B4 | 10.5 | 11.4 | 11.4 | 12.8 | 14.8 | 15.2 | 10.5 | 10.6 | 10.2 | 10.0 | 10.5 | 10.7 | 8.9 | 9.7 | 9.7 |
| *15 | P10 | 10.1 | 11.5 | 11.8 | 12.4 | 16.4 | 16.9 | 10.3 | 10.4 | 10.5 | 9.7 | 9.9 | 10.5 | 8.7 | 9.5 | 9.2 |

* A total of 30 trials were swum on these days.

*Results:* The swimming times for each day's performance for all the animals and for the 4 groups separately are given in table 2 and plotted in figure 2. Table 2 was constructed as follows. The median swimming time for each animal was found for trials 1-5, 6-10, and 11-15. The mean of these medians was then calculated for each group to provide the data as given in the table. The median was chosen in preference to the mean as the measure of central tendency of 5 trials to minimize the influence of an occasional aberrant or slow trial.

The outstanding characteristic shown in the table is that as practice continued swimming times decreased for the later trials, both 6-10 and 11-15. It seems a fair inference that the rats were not fatiguing as much as they were at the beginning of the practice program. This decrease was characteristic of all groups but was most spectacular in the case of the old males who on the first day swam trials 1-5 in 14.3 sec. and the 11-15 trials in 24.7 sec. By Day 7 (P4) these times had dropped to 12.4 and 16.2 sec., respectively. The old males eventually established a time of about 15 sec. for the last 5 trials.

In order to illustrate how this practice effect was influencing performance, table 3(a) presents the median swimming time for the first 5 trials for each group of rats, while column 2 presents, for trials 6-15, the mean time increase per trial. In column 5 the increase in the me-

TABLE 3(a). MEAN TIME INCREASE PER TRIAL (M.T.I.T.) AND PERCENTAGE INCREASE OVER 5 INITIAL SWIMMING TRIAL TIMES FOR 10 ADDITIONAL TRIALS ON FIRST 12 DAYS OF PRACTICE. ALL TIMES ARE GIVEN IN SECONDS.

| Day | Condition* | All Animals | | | Old Males | | | Old Females | | | Young Males | | | Young Females | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Time on Trials 1-5 | M.T. I.T. | % Increase over Initial Time† | Time 1-5 | M.T. I.T. | % Increase | Time 1-5 | M.T. I.T. | % Increase | Time 1-5 | M.T. I.T. | % Increase | Time 1-5 | M.T. I.T. | % Increase |
| 1 | P1 | 11.7 | .43 | 36.7 | 14.3 | 1.04 | 72.7 | 10.7 | .21 | 19.6 | 11.7 | .31 | 26.5 | 9.9 | .12 | 12.1 |
| 2 | P2 | 11.3 | .42 | 37.2 | 13.5 | .84 | 62.2 | 10.8 | .33 | 30.5 | 11.0 | .43 | 39.1 | 9.7 | .08 | 8.2 |
| 3 | Es. | 11.1 | .42 | 37.8 | 13.1 | .70 | 53.4 | 11.6 | .32 | 27.6 | 10.6 | .54 | 50.9 | 9.3 | .08 | 8.6 |
| 4 | P3 | 10.8 | .40 | 37.0 | 13.2 | .75 | 56.8 | 11.1 | .31 | 27.9 | 10.4 | .35 | 33.6 | 8.7 | .15 | 17.2 |
| 5 | B1 | 11.0 | .17 | 15.4 | 13.7 | .30 | 21.9 | 10.2 | .17 | 16.6 | 10.7 | .13 | 12.1 | 9.4 | .06 | 6.4 |
| 6 | B2 | 10.9 | .26 | 23.8 | 13.4 | .38 | 28.3 | 10.6 | .34 | 32.1 | 10.5 | .17 | 16.2 | 9.1 | .14 | 15.4 |
| 7 | P4 | 10.0 | .18 | 18.0 | 12.4 | .38 | 30.6 | 9.9 | .20 | 20.2 | 9.6 | .10 | 10.4 | 8.2 | .02 | 2.4 |
| 8 | P5 | 10.5 | .15 | 14.3 | 12.6 | .48 | 38.1 | 10.7 | −.02 | −1.9 | 9.8 | .11 | 11.2 | 9.1 | 00 | 0.0 |
| 9 | P6 | 10.4 | .12 | 11.5 | 13.2 | .26 | 19.7 | 10.2 | .05 | 4.9 | 9.4 | .15 | 15.9 | 9.0 | .01 | 1.1 |
| 10 | B3 | 10.5 | .13 | 12.8 | 13.1 | .22 | 16.8 | 10.4 | .05 | 4.8 | 9.5 | .15 | 15.7 | 9.1 | .07 | 7.7 |
| 11 | P7 | 10.1 | .10 | 9.9 | 12.4 | .23 | 18.5 | 10.1 | −.02 | −2.0 | 9.3 | .13 | 13.9 | 8.6 | .07 | 8.1 |
| 12 | P8 | 10.8 | .11 | 10.2 | 13.4 | .31 | 23.1 | 10.3 | .06 | 5.8 | 10.3 | .06 | 5.8 | 9.4 | −.02 | −2.1 |

TABLE 3(b). DATA FOR 30 TRIALS ON LAST THREE DAYS OF PRACTICE. TIME IN SECONDS.

| Day | Condition | All Animals | | | Old Males | | | Old Females | | | Young Males | | | Young Females | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Time on Trials 1-5 | M.T. I.T. | % Increase over Initial Time | Time 1-5 | M.T. I.T. | % Increase | Time 1-5 | M.T. I.T. | % Increase | Time 1-5 | M.T. I.T. | % Increase | Time 1-5 | M.T. I.T. | % Increase |
| 13 | P9 | 10.6 | .11 | 25.5 | 12.7 | .22 | 42.5 | 10.6 | .08 | 18.8 | 10.0 | .10 | 24.0 | 9.2 | .03 | 9.8 |
| 14 | B4 | 10.5 | .10 | 22.8 | 12.8 | .19 | 38.3 | 10.5 | .06 | 14.3 | 10.0 | .06 | 14.0 | 8.9 | .06 | 16.8 |
| 15 | P10 | 10.3 | .14 | 34.9 | 12.4 | .38 | 75.8 | 10.3 | .10 | 23.3 | 9.7 | .08 | 21.6 | 8.7 | .03 | 9.2 |
| | Unpracticed Animals for *30* Trials | | | | | | | | | | | | | | | |
| X | — | 11.3 | .74 | 163.7 | 14.1 | 1.85 | 328.0 | 10.9 | .09 | 158.7 | 10.8 | .27 | 62.0 | 9.4 | .17 | 44.7 |

* P, placebo; Es, eserine; B, benzedrine.

† Percentage increase in swimming time by trial 15 (M.T.I.T. x 10/ mean time per initial trial (trials 1-5)).

dian time for trials 11-15 is expressed as a percentage of the initial swimming time. For the old males the mean time increase per trial (M. T.I.T.) was of the order of 0.84 to 1.00 on the first practice days, but dropped to a low of 0.22 and 0.23 toward the end of the experiment. The three remaining groups did not show such marked improvement, but both the old females and young males on the first practice days showed 20 to 30% increases over their initial swimming times, which by the end of the practice session had fallen to nearly zero for the old females and less than 10% for the young males. The young females did not fatigue markedly over 15 trials at the beginning of the practice sessions and there was no clear trend in their results except that their initial swimming times tended to be slightly faster on the later practice days.

When we consider the initial swimming times it is clear from figure 2 that they did not change so strikingly with practice as the "fatigue" times for the later trials. For the group as a whole very few of the initial swimming times from day to day were significantly different from one another, although it might be noted that the times for each of the last 7 practice days (P4-P10) were lower than those for the first 3 (P1-P3). Within the groups the initial times were very consistent. The old males on every day without exception were the slowest and the young females the fastest swimmers. It may be concluded that intensive practice over a month in this study did not substantially change the initial swimming speeds of the old males.

*Practice effects upon swimming 30 trials:* On the last three days the rats were swum over 30 trials, for which the results are given in table 3 (b).

When these data are compared with those obtained in Experiment A (last line, table 3 (b)) over the same 30 trials the striking degree of improvement through practice is apparent. All animals were now able to complete the 30 trials, whereas originally half of the older males had failed to do so; now the median time for that group was less than 20 sec. on two of the three days. For every group the original percentage increase in swimming time over the 30 trials has been more than halved.

*Drug effects:* An attempt was made to ascertain an effective dosage by administering various amounts to control animals and observing their overt behavior. When eserine in doses of 0.5, 0.2, and 0.1 mg. per Kg. body weight was given (I.P.) several rats only swam intermittently and often assumed a curious "stretched-out" or extended posture and floated motionlessly. On Day 3 (Es) the experimental rats were accordingly given a smaller dose, 0.05 mg. per Kg., and were swum a half-hour later. This dosage had no effect on the swimming times of the rats. However, in view of the behavioral influence at the larger dosages, it seemed unlikely that eserine would improve swimming speeds and no further trials were made with the drug.

After trying various dosages of benzedrine on control rats, the experimental animals were given 4 mg. per Kg. on Day 5 (BI). This dosage had a marked effect on general behavior; the rats were active and "searched" vigorously in their cages. But this did not result in faster initial trials, where, if anything, there was a tendency for the drug to bring about some degree of disorganization. The rats were more active than hitherto in the water and their body movements were more vigorous, but their swimming, particularly that of the young females, was not as smooth and coordinated. It seemed to the investigators, however, after 5 to 8 trials the rats had passed an initial "burst of energy," and it was noticeable that they were then swimming in an undeviating straight line with no momentary pauses. At this stage of their practice it was a highly impressive performance which the animal had certainly not hitherto accomplished. Out of the last 5 trials for all the rats, 120 in all, there was no exception to this smooth uninterrupted progression. As a result the last 5 trials were little or no longer than their middle 5, whereas in all previous days there had been a statistically significant difference between the times for the middle 5 and last 5 trials.

This dosage was repeated 48 hours later and again it was observed that the rats did not slow as rapidly on the later trials, but several animals showed obvious signs of motor disturbance on their initial trials and in their general behavior. In so far as these animals seemed more disturbed than on the first occasion, it seemed possible that there were some residual effects from the first administration of the drug. Twenty-four hours after the second dose of benzedrine (P4) all groups of rats swam their initial trials quickly and their times were sta-

tistically better than their fastest trials to date. This was an impressive result, although further practice later improved the rats' swimming to a point equal to that on the benzedrine and the P4 trials, while no similar improvement was observed on the two later occasions when the drug was given. These results suggest that the benzedrine was responsible for the quicker swimming of the rats on the later trials on B1, and to this extent did act as an anti-fatigue agent. The remaining considerations are intriguing but not proved. The shape of the practice curve as a whole does show a pronounced dip at and just subsequent to the benzedrine trials while the initial times for P4 are significantly faster than those for all previous control trials. It might be that through the agency of the drug these animals did improve their performance more rapidly than they would have done by practice alone. But the present data are not adequate to settle this issue though it would seem to be a possibility worthy of further investigation.

## DISCUSSION

*Fatigue and Practice:* The initial study established large differences in the rate at which older and younger groups of rats fatigued during the course of 30 swimming trials. This experiment, (B), makes it clear that these performances could be subsequently improved with repeated practice distributed over a period of a month. Such practice did not serve to change the rank order of the age groups, the old males remaining much the slowest performers, but even so, a task which to them was initially exhausting and well-nigh impossible was completed at the end with little outward sign of distress (and every indication of control). It would seem of some import to aging studies that the old males were able to achieve such manifest improvement. These were distinctly old animals which had lived their entire life in the laboratory cages and with no previous swimming practice, but within the space of the experiment they substantially changed their performance.

It was a feature of all groups that after the 7th (P4) day there was no further improvement in the initial swimming speeds. It might therefore seem that the rats were performing at their maximum possible swimming speed, but in view of the stability of the speeds over 15 trials it is equally plausible that the rats were distributing their effort over the whole number of trials, in which case it might be expected that the initial trials would not improve as long as there was any serious decline on the later trials. The marked improvement in "fatigue" times would make it plausible to suggest that the rats had learned to swim 15 continuous trials, rather than to begin swimming at the higher possible rate.

*Drug effects:* The present attempt to influence gross behavior by means of drugs raises some issues for interpretation as well as for further work: 1) method of selecting drug dosage, 2) level of skill at which the drug is introduced, and 3) measurement of drug effects upon component skill elements in comparison with effects upon adaptiveness. Selection of an appropriate dosage is at one level limited by physiological effects, and at another by behavioral effects. A dosage which may be acceptable physiologically may not prove useful because of behavioral consequences or side effects which preclude observation or measurement of the skilled behavior. In the latter case the component elements of the skill may be unchanged yet the animal may show behavioral disorganization. Thus motivation to incur fatigue can conceptually be distinguished from resistance to fatigue even though empirically it may be difficult to separate them. In the same sense a drug may influence the adaptiveness of the animal to the training context or practice without directly influencing the mechanisms involved in, e.g., learning or fatigue. These issues point to the fact that drugs can have beneficial or deleterious side effects on the organization of skilled performance yet spare component processes. It is also important to consider the level of practice or skill at which a drug is introduced since by implication the drug effect will vary as a function of the level of skill and level of task complexity.

## SUMMARY

This study investigated age differences in fatigue in rats on a continuous performance task, swimming (previously shown to reveal age difference in speed), and observed the effects of practice and drugs upon speed of swimming and fatigue.

In the first experiment, a total of 40 albino rats was observed; there were equal numbers of old and young males and females, the two age groups being 23-27 months and 7-8 months.

After an initial practice day, the rats were given 30 consecutive swimming trials followed by 5 minutes' rest, and 5 more consecutive trials. All age groups fatigued over the 30 trials, but the old males showed the greatest effect; they initially took longer, were slower by 50% in the first 10 trials, and by the end of the session only 5 of the 10 rats could complete the 30 trials. In contrast, only one other rat, an old female, failed in this respect. The recovery trials indicated that the rats had not dissipated the effects of fatigue, for the fall-off in performance was faster over these 5 trials than in the first 5 of the 30 trials. Again the old rats declined more quickly than the young; of the 10 old males, only one completed the 5 trials, in contrast to the two young groups where all succeeded.

In the second experiment, the effects of practice on maximum performance and fatigue were studied by extended swimming of a group of 24 rats, made up of equal numbers of males and females, young and old. Rats were swum on 12 days for 15 trials each. The result of practice was to reduce evident fatigue in all groups but was most marked for the old males. For the old males the mean time increase per trial was reduced from 0.84 to 1.00 sec. in the first practice days to about 0.23 sec. toward the end of the experiment. Extensive practice did not, however, substantially change the initial, i.e., maximum speed.

Eserine and benzedrine were administered (I.P.) in an attempt to improve swimming performance. Side effects of both drugs at high dosage were evident in leading to a disorganization of smooth swimming performance. Further work is necessary to distinguish possible desirable effects of drug action on speed and fatigue from practice *per se* within the range of dosage where disorganizing behavioral side effects are minimal.

The results of these studies indicate that practice can influence to a large extent the susceptibility of animals to fatigue on a continuous task. Also, it was found that old males which fatigued most were improved most by practice. In contrast practice had small influence on initial or maximum swimming time, suggesting that the slowing in performance with age may not be an adaptive phenomenon; alternatively it might be viewed as evidence that the animals learned to swim the task of 15 trials as a whole distributing equal effort as much as possible.

## REFERENCES

1. Birren, J. E., and Kay, H.: Swimming Speed of the Albino Rat: I. Age and Sex Differences. *J. Gerontol., 13:* 374-377, 1958.
2. McCay, C. M., Lovelace, F., Sperling, G., Barnes, L. L., Liu, C. H., Smith, C. A. H., and Saxton, J. A., Jr.: Age Changes in Relation to the Ingestion of Milk, Water, Coffee, and Sugar Solutions. *J. Gerontol., 7:* 161-172, 1952.

JOURNAL OF GERONTOLOGY

VOLUME 13, NUMBER 4
OCTOBER, 1958

# Section B

## Psychological and Social Sciences, Social Welfare

Edited by

Robert J. Havighurst, Ph.D.
Bernice L. Neugarten, Ph.D.

# General Information

THE JOURNAL OF GERONTOLOGY is a quarterly journal owned and published by Gerontological Society, Inc. It publishes original manuscripts and review articles dealing with or bearing on the problems of aging from the fields of natural and social sciences. Preference will be given to manuscripts containing observational data.

Gerontological Society, Inc. and the Editors accept no responsibility for the views and statements of the authors as published in their original communications.

*SECTION B*

## INSTRUCTIONS TO CONTRIBUTORS

*Lack of adherence to instructions may result in delay of publication.*

1. Manuscripts for Section B should be addressed to Dr. Robert J. Havighurst or to Dr. Bernice L. Neugarten, University of Chicago, Judd Hall, Chicago 37, Illinois.
2. Papers should rarely exceed 20 typewritten pages, including tables and illustrations. They must be double spaced on white paper 8½" x 11" and submitted in duplicate.
3. A condensed title for running page headline, not to exceed forty letters and spaces should be supplied.
4. The author's academic degrees and the institution with which he is affiliated should be indicated on the title page.
5. Tables should be typed on separate sheets. Tabular matter in excess of 10% of the cost of composition and printing of the manuscript is to be at the expense of the authors.
6. Legends for illustrations should be typed (double space on separate sheets). Each plate must be arranged by the authors. Engraving charges in excess of 10% of the cost of composition and printing of the manuscript are to be at the expense of the authors. If illustrations are larger than the manuscript sheet size, small prints, as well as the original drawings, should be submitted with the manuscript to facilitate mailing to reviewers. The desired reduction of figures should be clearly indicated on the margin of the drawing. Drawings should be in India ink on white paper, and if background lines are used, they should be blue. All lettering should be done with a lettering guide large enough to give 2 mm. letters in the final Journal reduction. Maximum plate size is 5½" x 8" (if legends are to be included on the same page, the length should be correspondingly less). Final single column plate width is 2¾". The name of the author, the number of the figure, and an abbreviated title of the article should be written on the margin of each illustration. All illustrations should be packed carefully with cardboard to avoid damage in mailing. Photographs and original drawings will be returned to the authors only when requested within 30 days after publication of the paper.
7. Authors are requested to limit the use of footnotes.
8. Every paper should end with a brief summary in which the points established by the investigation are outlined.
9. For matters of editorial style (references, footnotes, tables, etc.) authors should refer to the Publication Manual published by The American Psychological Association, Inc., 1333 16th Street N.W., Washington 6, D.C.
10. Articles may be submitted to the JOURNAL in a foreign language, but if accepted must be translated at the responsibility and expense of the authors.
11. Reprint price list and order blank will be sent to author with galley proof.
12. Submission of a paper to this Journal is held to imply that it has not been published, is not under consideration for publication elsewhere, and, if accepted for the JOURNAL OF GERONTOLOGY, is not to be published elsewhere (except as Society Proceedings) without permission from the JOURNAL OF GERONTOLOGY.
13. The JOURNAL OF GERONTOLOGY is not responsible for manuscripts or illustrations.

* * * *

Subscription prices beginning with volume 8, 1953: in the United States and Canada, $10.00 per volume; in other countries, $10.50 (the equivalent of $10.50 in U.S. currency on the day of transfer). Single copies of the JOURNAL are available at $2.50. Back issues, 1946-1949, are $6.00 a volume; 1950-1952 issues are $8.00 a volume, plus 50c postage to foreign countries. Checks should be made payable to the JOURNAL OF GERONTOLOGY. New subscriptions and renewals are entered to begin with the first issue of the current volume. Four weeks' notice is required for change of address.

Publication office is at 1712-24 Chouteau Ave., St. Louis, Missouri. Editorial Offices are at 660 South Kingshighway Blvd., St. Louis 10, Missouri, and Judd Hall, University of Chicago, Chicago 37, Illinois. All communications and remittances relating to subscriptions, back volumes, advertising, reprints, etc., should be directed to the office of the Editor-in-Chief, 660 South Kingshighway Blvd., St. Louis 10, Missouri.

---

Entered as second class matter at the post office of St. Louis, Missouri.

Copyright © 1958 by Gerontological Society, Inc. All rights in the JOURNAL OF GERONTOLOGY are reserved. No part may be reproduced in any form whatsoever without permission in writing from the JOURNAL, except by a reviewer who wishes to quote brief passages in connection with a review.

VOLUME 13, SECTION B OCTOBER, 1958 NUMBER 4

# SEX HORMONE REPLACEMENT IN THE AGED: I. PSYCHOLOGICAL AND MEDICAL EVALUATION OF ADMINISTRATION OF ANDROGEN-ESTROGEN AND OF ANDROGEN-ESTROGEN COMBINED WITH RESERPINE*

JEROME D. PAUKER, Ph.D., TEOFIL KHEIM, M.D., IVAN N. MENSH, Ph.D., AND WILLIAM B. KOUNTZ, M.D.

*(Washington University School of Medicine, St. Louis)*

A number of medical investigators (4, 8, 12) have reported beneficial effects of sex hormone replacement in the aged. In contrast to these reports, psychological studies have indicated either no change in psychological status (8) or limited change (6). The differences in findings are not surprising in view of the differences among the studies in type of hormone used, in subjects, in dosage level and period of administration, and in methods of evaluation.

The primary purpose of the present experiment was to study specific psychological functions as they were observed in an aged, hospitalized, non-psychiatric population, following a period of therapy with androgen-estrogen hormones and with androgen-estrogen plus reserpine. The hormone-reserpine combination was included on the assumption that there might be a synergistic action between the two drugs. Concurrently with the psychological evaluation, the subjects were evaluated medically.

## RESEARCH DESIGN

In the general design of the experiment a group of subjects was selected from the total hospital population in accordance with certain specific criteria described below. The patients were divided among three groups equated on the bases of psychological tests and evaluation (Test Series I); medical ratings; and relevant social data, including sex, age, and length of hospitalization. Each group was assigned at random to one of three drug administration categories: androgen-estrogen, androgen-estrogen combined with reserpine, and placebo. Drug administration (including placebo) was instituted and continued for a period of five months. At the end of this period the patients were again evaluated, both medically and psychologically (Test Series II), and drug administration was discontinued. Following a three month "withdrawal" period the evaluations again were made (Test Series III).

## THE SUBJECTS

The subjects were chosen from among the patients at the St. Louis Chronic Hospital who are principally from lower economic, social, and educational backgrounds. Most of the patients are in the older age group, the mean age for men being about 72 and the mean age for women about 73.

The criteria for selection of subjects, in addition to the medical criteria, were that the patient had to be able to come, or be brought, to the place on each ward where testing was to be done; he had to be able to understand what was being said to him and to communicate his responses; he had to be nonpsychotic; he could not have participated in hormone or psychological studies during the previous three years.

The subjects were screened at the beginning of the study by physical and, in the case of the female patients, gynecological examinations, and by biochemical laboratory tests. None of the patients was acutely ill. The majority of the patients (61 per cent) had a primary diagnosis of some form of cardiovascular disease. The next most frequent group of primary diagnoses (16 per cent) concerned diseases of the bones and joints. The rest of the patients carried a variety of diagnoses, including emphysema, anemia, asthma, tuberculosis, and diabetes. One patient with a primary diagnosis of "mild psychosis" was mistakenly included in the original group; she was subsequently dropped from the study. The majority of sec-

* This study was supported by a research grant from Ciba Pharmaceutical Products, Inc.

ondary diagnoses also pertained to cardiovascular diseases.

In addition to the laboratory tests, the patients were interviewed and observed for evidence of vasomotor disturbance, nervousness, depression, easy fatigue, headache, palpitation, vertigo, arthralgia, vaginal bleeding, and sense of well-being. Each patient was given a medical rating on a five-point scale of general health, with a rating of one assigned to those in the best physical condition and a rating of five given to those in poorest health.

The initial psychological test scores, medical ratings, and social data of 105 patients were given to a medical psychologist[1] who divided the patients into three groups, equated for these variables.

*Drugs*

The drugs and placebos were supplied by Ciba Pharmaceutical Products, Inc. The hormones, ethinyl estradiol (0.02 mg.) and methyltestosterone (5.00 mg.), were combined in one tablet (Femandren, Ciba). This tablet (or Linguet) is dissolved in the mouth for absorption via the oral mucosa directly into the blood stream (2). The reserpine (Serpasil, Ciba) was combined in a Linguet with the hormones for administration to the hormone plus reserpine group. Each of these Linguets contained 0.20 mg. Serpasil in addition to the amounts of hormone indicated above. The placebos were identical with the other Linguets in size, shape, and color. Each patient was given one Linguet daily during the five-month treatment period.

*Original and Attrited Samples*

One hundred and five aged, white patients (44 male and 61 female) constituted the original sample. During the following five months, the groups gradually became reduced in size. Of the original group of 105 patients, 43 were dropped from the study for various reasons, leaving a total sample size at the post-administration level (Test Series II) of 62 patients.

Four factors account for 74 per cent of the subjects dropped from the original sample: death (11 cases), refusal to take medication (eight cases), discharge from the hospital (seven cases), and medications stopped for medical reasons (six cases). The loss due to death is contributed to by all three of the treatment groups. Seven of the eight subjects who refused medication were females, and the majority were members of the Hormone-Reserpine group. One woman in the Hormone group refused the Linguets following vaginal bleeding, and another in that group did not want to continue because of nausea. Of the four women in the Hormone-Reserpine group who refused treatment, three did so because of vaginal bleeding. One woman in the Placebo group suffered stomach pain and would not take the placebo Linguets. Three males and three females were withdrawn for other medical reasons. The Hormone-Reserpine combination was withheld from two women who became confused, from one woman who developed a swollen abdomen, from one man whose breasts became sore and swollen, and from another man whose health declined. One male in the Hormone group began to suffer from nausea and drug administration was subsequently discontinued. Four patients were transferred to other hospitals, for purposes of medical observation or treatment. Four more patients were dropped from the study when it was strongly suspected that they were not taking their medication. One more patient was dropped from the Placebo group when it was discovered that he was being administered reserpine on orders of his ward physician.

The 62 patients remaining were distributed among the three groups as follows: 22 in the Hormone group, 16 in the Hormone-Reserpine group, and 24 in the Placebo group.

The chi-square test was used to compare the actual attrition in the three treatment groups with that which might be expected on the null hypothesis that the attrition in each group was equal. The chi-square value of 1.35 is not significant at the .05 level of probability. The null hypothesis cannot be rejected, i.e., there is not statistical evidence that the differences among the treatment groups in amount of attrition can be attributed to other than chance fluctuation.

Comparison of the original and attrited samples showed close correspondence between the two samples in age, months of hospitalization, and medical rating, and a similar correspondence was seen in mean test and evaluation scores. As a further check, an analysis of variance and an extension of the median test were performed on the pre-administration evaluation and historical data of the attrited sample to see how well the groups were matched following attrition. The results of these analyses showed that, despite the attrition, the treatment groups remained well equated.

The range, mean, and standard deviation for age, months of hospitalization, and medical rating for each of the sexes and for each of the attrited groups (which will now be called the experimental groups) are shown in Table 1.

Between the post-administration evaluation and the post-withdrawal period evaluation the sample was further reduced in size by six sub-

[1] The help of Dr. A. Jack Hafner, Washington University School of Medicine, is gratefully acknowledged.

TABLE 1. COMPARISON OF ORIGINAL AND ATTRITED[a] SAMPLES WITH RESPECT TO AGE, MONTHS OF HOSPITALIZATION, AND MEDICAL RATING.

| Treatment Group | | | Age | | | Months of Hospitalization | | | Medical Rating | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| Hormones | Original N = 35 | Range | 60–90 | 59–91 | 59–91 | 1–44 | 5–123 | 1–123 | 1–5 | 1–5 | 1–5 |
| | | Mean | 75.0 | 76.2 | 75.7 | 25.2 | 48.6 | 37.9 | 3.1 | 2.9 | 3.0 |
| | | S. D. | 8.0 | 7.8 | 7.9 | 14.6 | 37.4 | 31.5 | 0.9 | 0.9 | 0.9 |
| | Attrited N = 22 | Range | 68–90 | 61–84 | 61–90 | 1–44 | 5–123 | 1–123 | 1–5 | 2–4 | 1–5 |
| | | Mean | 77.5 | 74.8 | 76.0 | 23.6 | 46.4 | 36.0 | 3.0 | 3.0 | 3.0 |
| | | S. D. | 7.2 | 6.2 | 6.8 | 15.4 | 40.6 | 33.7 | 1.1 | 0.8 | 0.9 |
| Hormones Plus Serpasil | Original N = 34 | Range | 60–85 | 60–89 | 60–89 | 1–127 | 2–192 | 1–192 | 1–4 | 2–4 | 1–4 |
| | | Mean | 74.2 | 78.1 | 76.5 | 49.4 | 55.4 | 52.9 | 2.6 | 2.9 | 2.8 |
| | | S. D. | 7.8 | 7.6 | 7.9 | 38.4 | 52.2 | 47.1 | 1.2 | 0.7 | 0.9 |
| | Attrited N = 16 | Range | 65–85 | 71–88 | 65–88 | 14–90 | 15–119 | 14–119 | 1–4 | 2–4 | 1–4 |
| | | Mean | 76.7 | 78.5 | 77.6 | 43.1 | 63.1 | 53.1 | 2.6 | 3.1 | 2.9 |
| | | S .D. | 7.2 | 5.8 | 6.6 | 27.7 | 44.0 | 38.1 | 1.4 | 0.6 | 1.1 |
| Placebo | Original N = 36 | Range | 58–83 | 55–89 | 55–89 | 9–139 | 7–166 | 7–166 | 2–4 | 2–4 | 2–4 |
| | | Mean | 73.1 | 77.5 | 75.8 | 64.6 | 49.9 | 55.6 | 3.0 | 3.1 | 3.1 |
| | | S. D. | 7.3 | 8.1 | 8.1 | 46.8 | 44.8 | 46.2 | 0.8 | 0.8 | 0.8 |
| | Attrited N = 24 | Range | 58–83 | 55–89 | 55–89 | 10–116 | 7–134 | 7–134 | 2–4 | 2–4 | 2–4 |
| | | Mean | 72.7 | 77.9 | 75.5 | 59.0 | 48.3 | 53.2 | 2.8 | 3.3 | 3.1 |
| | | S. D. | 7.6 | 8.9 | 8.7 | 42.5 | 41.7 | 42.4 | 0.8 | 0.7 | 0.5 |

[a] Attrition by reason of death, discharge, transfer, medication refused, medication removal, incompatible medication administered, and inability to be tested.

jects: one patient died (a female in the Hormone-Reserpine group), three patients were discharged from the hospital (one male and one female in the Hormone group, and one female in the Placebo group), and two patients could not be tested (a male in the Hormone group and a female in the Placebo group). This left a sample size of 56 subjects at Test Series III.

## MEDICAL EVALUATION

### *Methods*

The research physician saw each patient two to three times a week and brief medical examinations and evaluations were made monthly. Such laboratory tests as complete blood count, nonprotein nitrogen, and fasting blood sugar were made, and blood pressure was checked three times a week.

### *Results*

During the course of the drug administration, alterations in physical and mental attitudes and in personality characteristics were observed in the subjects of the two drug groups as compared with those of the Placebo group.

*Hormone group.* After a few days of hormone administration, a sense of well-being and elevated mental and physical activity were seen in eight of the female subjects. The sense of well-being lasted, with short interruptions, throughout the first three months of hormone administration, during which time four more subjects showed the same change. Many of the postmenopausal symptoms such as fatigue, irritability, vasomotor disturbances, and nervousness disappeared or were at least partially alleviated. Three of the females spontaneously said that they felt like 18-year-olds.

Seven of the male subjects had an elevation in mood which became noticeable in the fourth week of the hormone administration. Not only was the onset of this elevation in the males quieter than in the females, but the degree of sense of well-being was lower.

A general tonic effect became apparent in both sexes during the second and third month of drug administration. During the second half of the fourth month and during the fifth month, all of the subjects developed some nervousness, followed later, in most of them, by some depression and aversion to the Linguet.

Three females showed marked depression, one male had some confusion, and another complained about blackouts, which did not re-

cur after the hormones were discontinued. One female subject became belligerent and quarrelsome at the end of the fourth month and remained so during the first two weeks of the withdrawal period. A common complaint, increasing toward the end of the five-month period, was slight stomach trouble and loss of appetite. One subject had cramps which disappeared when the Linguets were temporarily discontinued, but which reappeared when administration was resumed.

*Hormone-Reserpine group.* An elevated mood occurred in the first week in seven females, which was very quickly overwhelmed by side effects of the reserpine. The side effects observed were nasal stuffiness, distended bowels, excessive sedation, bizarre night dreams, physical weakness, and dizziness and confusion. These side effects were more or less present in 14 of the female subjects, but only in five of the males. Four to seven days after the end of the drug administration period all complaints subsided and an elevated mood became apparent in all the patients. This change lasted for two to three weeks, after which the mood subsided to the pre-drug level.

The abdominal distention appeared as the first side effect, and in two females it became necessary to discontinue the drugs temporarily. During the third month, the only male who indicated major distention of the abdomen was removed from the drugs for two weeks. After seven weeks, two females became so confused and disoriented that it was necessary to stop medication. During the fifth month there was some confusion of lesser intensity revealed in one male and two females. Every attempt to resume drug administration to the confused patients resulted in more confusion. Drowsiness was a common complaint of both sexes. It occurred markedly in eight females and in one male (as contrasted with only two females in the Hormone group). This complaint increased toward the end of the fourth month and in the fifth. As with the Hormone group, slight stomach trouble and loss of appetite was a common complaint during the last third of the drug administration period, increasing in the fifth month. Three subjects with stomach cramps found relief with temporary withdrawal of the drugs, but the cramps reappeared when the drug administration was resumed.

Soreness of the breasts was noticed in one female at the end of the first week, recurring twice for shorter periods of time later in the study. Gynomastia to a greater extent was seen in three males during the fourth and fifth months. One of them had a painfully swollen face at the end of three months which lasted for three weeks.

Vaginal bleeding was one of the most troublesome effects of the experiment, occurring in ten females of the Hormone-Reserpine group and one subject in the Hormone group. In six of the total of eleven subjects, the bleeding began in the last third of the second month, in four cases it started at the end of the third month, and for one case it began in the fourth month. There were no signs of bleeding during the withdrawal period. We could find no explanation for the markedly higher incidence of vaginal bleeding in the Hormone-Reserpine group.

*Summary and Discussion of Medical Evaluation*

There were beneficial results noted in both the Hormone and Hormone-Reserpine groups, as contrasted with the Placebo group. The changes in the Hormone group were more marked and consistent, mainly, it seemed, because of deleterious side effects of reserpine which appeared in the Hormone-Reserpine group. In the Hormone group, an elevated mood and sense of well-being occurred in the first half of the five-month drug administration period. These favorable, general tonic effects, better mental outlook, and improved disposition became gradually reduced, and in many cases almost lost, after three months of hormone administration. At that time such undesirable symptoms as nervousness, stomach troubles, and dizziness appeared in both sexes. In the Hormone-Reserpine group, the elevated mood and sense of well-being lasted only eight to ten days, and the clinical picture was almost entirely governed by such undesirable side effects of the reserpine as excessive sedation, nasal suffiness, abdominal distention, and confusion. Vaginal bleeding occurred in one female of the Hormone group and in ten females of the Hormone-Reserpine group.

Sex hormone replacement, then, may be a significant contribution to the well-being of elderly persons. Full sex hormone replacement may, however, be unnecessary, especially in view of the fact that the favorable general tonic effect was markedly reduced after three months of administration at the recommended dosage.

With regard to the combination of sex hormones with reserpine, our conclusion is that reserpine, if necessary, should be given in separate tablets according to individual needs, with little to be gained by routine combination.

## PSYCHOLOGICAL EVALUATION

### *Methods*

The particular functions chosen for study were selected on the basis of clinical observations frequently reported in the literature on hormone replacement.

Four parts of the Wechsler Memory Scale (15) were used to assess memory: personal and current information, orientation, mental control, and digit span.

A Words per Minute test was included as a measure of verbal association fluency. The subject is required to say as many words as he can in one minute.

The Seguin Form Board test (3) requires that the subject place ten geometrically shaped wooden figures in appropriate recesses cut into a large board. Each subject was given two trials, with favorable and encouraging comment made by the examiner following the first trial. This test was chosen to provide a measure of psychomotor response to encouragement. It seems also to exert a certain amount of psychological stress in the request for quicker performance on the second trial.

Each subject was required to give the names of some of the hospital physicians, nurses or attendants, and patients. The intent of this test, which we called Attention to Others, was to evaluate the extent of the subject's attention to people around him.

The Geometric Figures test, a modification of a test devised by Mandl (11), was used to display the ease or difficulty with which the subject responded to a situation involving a reorganization of past habit, or requiring a response contrary to previous set. The subject was required to give the names of four geometric figures, which were printed on cards in varying order, and was then required to reverse the names of two of the figures.

In order to obtain a standard measure of the mood of the subjects, the Sentence Completion method was chosen because it could afford objective and reliable scoring (11, 13). For the present study, 21 sentences were used and the completions rated on a five-point scale for mood or feeling-tone (positive to negative). Each subject then received two scores; one, the mean of his scores on the 21 sentences, and two, the standard deviation of his scores as an indication of individual variability.

A behavior-sampling procedure was developed in response to the need for a simple and reliable way of recording and evaluating physical activity. The method was designed so that the observations could be performed with very little training, so that it would take very little time, and so that it would involve as little interference as possible in ward activity. The observer (a research nurse[2]) would find the patient she wished to observe, and then would write down what the patient was doing at the moment she first saw him. Observations were made three times a day, two days a week, for two successive weeks; twelve observations were made on each subject for each testing series. The activities which were most frequently observed were given to five judges to rate on a seven-point scale for amount of physical activity indicated. As a result of these ratings, a score was assigned to each item of activity, and these scores were applied to the items of behavior observed by the research nurses. Each patient then received a total Physical Activity score.

In looking at the behavior-sampling data, it was seen that they might also be considered from the viewpoint of the intellectual complexity involved in the behavior shown by the patient. It could be assumed, for example, that playing chess or reading a newspaper are more complex intellectual activities than eating a candy bar or walking down a corridor. The same five judges used before again rated the items of behavior on a seven-point scale, this time for degree of intellectual complexity shown, and each patient received a total Intellectual Complexity score.

The psychological testing and scoring of the test data were done by the psychologist without knowledge of the group to which the patient belonged. Both Test Series II and Test Series III were scored at the same time, and all the records of one test were scored at one time.

### *Results*

Table 2 gives the means and standard deviations for the data, by experimental group and by sex. Among the mean scores the trends for all three experimental groups seem to be toward slight to moderate declines from Test Series I to Test Series II, with a few of the scores remaining about the same and fewer still showing some increase. The three mean score increases were distributed one to each of the experimental groups.

Test Series II supplies the crucial data for this study. Since, as we have shown, the treatment groups were equated at the pre-administration evaluation, any effects due to differences in treatment would be expected to show up as differences among the groups in test scores at the post-administrative evaluation.

None of the analyses of covariance computed for each test resulted in a significant F-ratio. Thus the null hypothesis, stating that there are no differences among the treatment groups in these test means, cannot be rejected. In other words, any differences among treatment groups could be accounted for on the basis of chance alone, and there is no evidence to support the hypothesis that psychological response to the hormones, or to the hormone-reserpine combi-

[2] We are indebted to several research nurses who contributed in this and other ways to the collection of data and to the smooth integration of the mechanics of the study in general: Frances Clark, R.N., Selma Krueger, R.N., Eva McVey, R.N., Tex Morgan, R.N., and Ruth Pisciotta, R.N.

TABLE 2. MEANS AND STANDARD DEVIATIONS OF THE PSYCHOLOGICAL TESTS AND METHODS: SCORED BY EXPERIMENTAL GROUP, SEX, AND TEST SERIES.

| Treatment Group | | Test Series I | | | Test Series II | | | Test Series III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| **Memory** | | | | | | | | | | |
| Hormone | Mean | 17.8 | 17.3 | 17.5 | 16.9 | 16.5 | 16.7 | 16.5 | 17.4 | 17.0 |
| | S. D. | 5.0 | 5.6 | 5.3 | 5.7 | 6.1 | 5.9 | 6.7 | 5.9 | 6.3 |
| Hormone-Reserpine | Mean | 20.5 | 17.9 | 19.2 | 19.5 | 18.4 | 18.9 | 21.1 | 18.1 | 19.7 |
| | S. D. | 3.9 | 5.4 | 4.9 | 3.6 | 5.7 | 4.8 | 3.8 | 5.8 | 5.0 |
| Placebo | Mean | 20.5 | 14.7 | 17.6 | 19.4 | 14.6 | 17.0 | 19.5 | 14.6 | 17.1 |
| | S. D. | 3.6 | 6.2 | 5.9 | 4.6 | 6.8 | 6.3 | 4.1 | 7.2 | 6.3 |
| **Attention to Others** | | | | | | | | | | |
| Hormone | Mean | 2.4 | 8.8 | 5.6 | 1.2 | 8.6 | 4.9 | 1.6 | 9.1 | 5.9 |
| | S. D. | 2.6 | 6.3 | 5.8 | 1.9 | 5.0 | 5.3 | 2.1 | 5.8 | 5.9 |
| Hormone-Reserpine | Mean | 6.2 | 8.5 | 7.4 | 6.9 | 9.1 | 8.0 | 6.7 | 8.6 | 7.6 |
| | S. D. | 6.4 | 5.5 | 6.1 | 6.3 | 6.4 | 6.4 | 6.2 | 6.5 | 6.4 |
| Placebo | Mean | 10.0 | 4.2 | 7.1 | 8.9 | 3.7 | 6.3 | 8.5 | 2.9 | 5.7 |
| | S. D. | 4.5 | 5.7 | 5.8 | 5.5 | 5.3 | 6.0 | 5.1 | 4.9 | 5.7 |
| **Words per Minute** | | | | | | | | | | |
| Hormone | Mean | 9.7 | 16.1 | 12.9 | 8.7 | 15.0 | 11.8 | 7.9 | 15.9 | 12.5 |
| | S. D. | 8.4 | 8.2 | 8.9 | 7.3 | 8.0 | 8.3 | 4.2 | 11.3 | 9.9 |
| Hormone-Reserpine | Mean | 18.7 | 16.1 | 17.4 | 14.1 | 11.9 | 13.0 | 18.9 | 13.9 | 16.5 |
| | S. D. | 10.0 | 8.0 | 9.2 | 10.3 | 3.9 | 7.9 | 7.8 | 7.3 | 8.0 |
| Placebo | Mean | 14.9 | 11.3 | 13.1 | 16.2 | 9.7 | 12.9 | 15.2 | 6.9 | 11.0 |
| | S. D. | 6.8 | 5.2 | 6.3 | 6.8 | 5.5 | 7.0 | 5.2 | 4.6 | 6.4 |
| **Sentence Completion** | | | | | | | | | | |
| Hormone | Mean | 2.7 | 3.1 | 2.9 | 2.9 | 2.8 | 2.9 | 2.9 | 3.0 | 3.0 |
| | S. D. | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | 0.6 | 0.5 | 0.5 |
| Hormone-Reserpine | Mean | 3.0 | 2.9 | 3.0 | 3.1 | 2.8 | 2.9 | 3.1 | 2.9 | 3.0 |
| | S. D. | 0.3 | 0.6 | 0.5 | 0.4 | 0.5 | 0.5 | 0.3 | 0.4 | 0.4 |
| Placebo | Mean | 3.1 | 2.9 | 3.0 | 3.0 | 2.8 | 2.9 | 3.1 | 3.0 | 3.1 |
| | S. D. | 0.4 | 0.3 | 0.4 | 0.4 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 |
| **Sentence Completion Variability** | | | | | | | | | | |
| Hormone | Mean | 1.1 | 1.2 | 1.1 | 1.0 | 1.2 | 1.1 | 1.0 | 1.2 | 1.1 |
| | S. D. | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| Hormone-Reserpine | Mean | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.1 | 1.1 | 1.2 | 1.1 |
| | S. D. | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Placebo | Mean | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.1 | 1.2 |
| | S. D. | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |
| **Physical Activity** | | | | | | | | | | |
| Hormone | Mean | 15.8 | 20.6 | 18.2 | 15.7 | 18.7 | 17.2 | 16.0 | 19.4 | 18.0 |
| | S. D. | 7.4 | 6.4 | 7.3 | 5.9 | 4.9 | 5.6 | 5.3 | 5.9 | 5.9 |
| Hormone-Reserpine | Mean | 19.2 | 21.2 | 20.2 | 16.9 | 16.0 | 16.4 | 16.2 | 17.7 | 16.9 |
| | S. D. | 5.7 | 11.2 | 9.0 | 5.6 | 4.2 | 5.0 | 5.2 | 5.4 | 5.3 |
| Placebo | Mean | 14.9 | 15.6 | 15.3 | 14.4 | 17.8 | 16.1 | 18.3 | 15.2 | 16.7 |
| | S. D. | 5.4 | 7.4 | 6.5 | 5.8 | 4.9 | 5.6 | 5.3 | 5.0 | 5.4 |

TABLE 2 CONTINUED.

| Treatment Group | | Test Series I | | | Test Series II | | | Test Series III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| Intellectual Complexity | | | | | | | | | | |
| Hormone | Mean | 13.4 | 28.8 | 21.1 | 16.6 | 19.7 | 18.1 | 15.9 | 23.5 | 20.3 |
| | S. D. | 8.6 | 9.1 | 11.8 | 9.7 | 9.2 | 9.6 | 9.9 | 7.7 | 9.5 |
| Hormone-Reserpine | Mean | 19.7 | 23.2 | 21.5 | 15.6 | 20.6 | 18.1 | 17.5 | 20.6 | 19.1 |
| | S. D. | 6.0 | 11.9 | 9.6 | 6.8 | 10.0 | 8.9 | 9.3 | 9.0 | 9.3 |
| Placebo | Mean | 16.1 | 23.6 | 19.9 | 18.6 | 19.3 | 18.9 | 19.4 | 19.0 | 19.2 |
| | S. D. | 7.4 | 10.1 | 9.6 | 10.0 | 6.7 | 8.5 | 6.6 | 10.3 | 8.7 |
| Geometric Figures | | | | | | | | | | |
| Hormone | Mean | 5.6 | 5.1 | 5.3 | 5.2 | 5.9 | 5.6 | 5.7 | 4.8 | 5.2 |
| | S. D. | 3.1 | 3.1 | 3.1 | 3.1 | 2.6 | 2.8 | 3.0 | 2.7 | 2.9 |
| Hormone-Reserpine | Mean | 6.1 | 5.0 | 5.6 | 5.2 | 6.0 | 5.6 | 6.2 | 5.6 | 5.9 |
| | S. D. | 2.5 | 2.6 | 2.6 | 3.3 | 3.2 | 3.3 | 1.7 | 3.3 | 2.6 |
| Placebo | Mean | 5.5 | 4.2 | 4.9 | 5.6 | 3.5 | 4.5 | 6.5 | 2.7 | 4.7 |
| | S. D. | 2.9 | 3.2 | 3.1 | 2.7 | 3.0 | 3.0 | 1.4 | 2.7 | 2.9 |
| Seguin | | | | | | | | | | |
| Hormone | Mean | 2.9 | 3.7 | 3.4 | 3.1 | 3.1 | 3.1 | 3.5 | 2.9 | 3.2 |
| | S. D. | 1.4 | 0.4 | 1.1 | 1.3 | 1.1 | 1.2 | 0.9 | 1.5 | 1.4 |
| Hormone-Reserpine | Mean | 3.1 | 3.2 | 3.2 | 2.9 | 3.6 | 3.2 | 3.7 | 3.0 | 3.4 |
| | S. D. | 1.0 | 0.8 | 0.9 | 1.8 | 0.7 | 1.4 | 0.4 | 0.9 | 0.8 |
| Placebo | Mean | 2.8 | 2.6 | 2.7 | 2.8 | 2.4 | 2.6 | 2.4 | 2.8 | 2.6 |
| | S. D. | 1.5 | 1.6 | 1.5 | 1.5 | 1.4 | 1.5 | 1.4 | 1.3 | 1.4 |

NOTE.—Because not all subjects completed all the tests satisfactorily, the number of subjects varies by sex, test, and Test Series in each of the three treatment groups. Furthermore, to keep the male-female ratio constant in computing analyses of covariance, a test score (selected at random) was sometimes dropped. The smallest N for any entry in this table is 7; the largest, 13.

nation, was significantly different from response to the placebo.

The extension of the median test was used with the data from the Geometric Figures Test and the Seguin Form Board. The resulting chi-squares were not significant at the .05 level, indicating that chance variation could well have produced the differences between groups.

The subjects were evaluated three months after they were withdrawn from drug administration in order to see if there were any lasting effects of the drugs, provided that effects of the drugs were seen in differences between experimental groups at the Test Series II level. With this later evidence lacking, no formal analysis was made of the Test Series III data. Inspection of the means in Table 2 reveals no notable change or trend from Test Series II to Test Series III, nor any notable differences among groups within Test Series III.

*Summary and Discussion of Psychological Evaluation*

The present study has not demonstrated significant psychological changes in an aged group following the administration of androgen-estrogen. One possible conclusion to be drawn from these results is that the administration of sex hormones may not have an effect upon the behavior of aged persons. This generalization seems unlikely, especially in view of the rationale underlying sex hormone replacement and in view of past research, both psychological and physiological (5, 10). The question then arises—under what conditions and in what situations may sex hormone therapy be most facilitated, and in what manner might these effects be manifested?

It should be pointed out that a chronic hospital population may not be the best group in which to look for improvement. It was usually

assumed at the hospital that the effect of institutionalization was in the direction of decreased interest and activity. It has been suggested (1, 9) that the presence of a stimulating environment is necessary for the preservation, if not the development, of a response mechanism. It also has been observed (7, 14) that lack of practice in learning may account for some learning disability among older adults. The same point has been made with respect to motor abilities (9). It might be expected, then, that psychological changes due to hormone therapy may be most apt to occur in an atmosphere in which the psychological functions would have the greatest stimulation. This, in fact, suggests a research design in which opportunity for intellectual and emotional stimulation would be an important variable.

The methods of evaluation used in the present experiment were selected to test for the changes in psychological functioning which clinical observations had reported to be present. The possibility exists that the subjects in this study may have shown changes in function which were not tapped. For example, no assessment was made of spontaneity of activity, level of social interaction, self-concept, or reaction to frustration.

A factor which is not included in this study is the judgment of the physician regarding the amount of medication for individual patients during the course of treatment. Every subject in a treatment group was given the same medication for the same period of time. This is not typical of the situation in medical practice in which dosage and duration of treatment will usually vary with the patient. While it is assumed in a study such as the present one that variations in response to treatment will vary randomly within the group, and that the group average will represent a mean optimal therapeutic response, it would appear that it would be worthwhile to exercise the clinical skill of the physician in a study in which sex-hormone administration would be adjusted to suit the needs of the individual patient.

## DISCUSSION

The results of the psychological and medical investigations in this study are at variance. The psychological evaluation showed no differences among the groups while the medical evalution resulted in the conclusion that the group to which androgen-estrogen was administered benefited by an elevated mood and sense of well-being. One reason for this variance in results may be that the psychological evaluation was made at the end of a five-month period, and might have missed the peak in patient well-being, a peak observed at the third month by those who were involved in the week-to-week medical assessment of the patients. Two possibilities arise: 1) the cumulative effect of the prescribed dosage of hormones may have resulted in a decline in well-being following three months of administration, and 2) lower dosage of hormones may have beneficial effects which are more long-lasting.

Another reason for difference in results may lie in the types of observations made. The methods and circumstances of the psychological observations were essentially the same for each patient. There was little room for subjective error since the experimental group to which each subject belonged was not known to the psychologist, since the test stimuli were not varied, and since each bit of test behavior was scored against a clearly defined standard. The medical evaluations, on the other hand, may have been open to subjective error in that it was known to which experimental group each patient belonged and in that the standard of judgment was the physician's personal experience with these patients.

On the other hand, the observations of the physician undoubtedly encompassed a broader range and variety of behavior in this study than did those of the psychologist. Such factors as social interaction and behavioral spontaneity which entered into the medical evaluation were not considered in the psychological assessment.

## SUMMARY

The main purpose of the present study was to observe aged subjects in several areas of psychological functioning, following the administration of androgen combined with estrogen.

One hundred and five non-psychiatric inpatients of the St. Louis Chronic Hospital were chosen. The subjects were divided into three groups, equated on the basis of psychological test results and relevant social and medical data, and these groups were then assigned at random to three treatment categories: androgen-estrogen, androgen-estrogen combined with reserpine, and placebo. At the end of five months of drug administration, 62 patients were reexamined.

The psychological evaluations showed no significant difference among the groups at the end of the period of drug administration. The medical evaluations, however, indicated that androgen-estrogen replacement was beneficial, and that a peak in well-being was reached at the end of three months of drug administration, followed by a reduction in the general tonic effect. The combination of hormones and reserpine in one tablet as standard practice was not recommended.

The findings of each type of evaluation are discussed, and some possible reasons for the variance in results are indicated.

## REFERENCES


1. Anderson, J. E. Assessment of aging. *Public Health Reports,* 1955, **70,** 839-842.
2. Anonymous. *Femandren Linguets.* New Jersey: Ciba Pharmaceutical Products, n.d.
3. Arthur, G. *A point scale of performance tests.* Vol. I. *Clinical manual.* New York: Commonwealth Fund, 1933.
4. Benjamin, H. Endocrine gerontotherapy: use of sex hormone combinations in female patients. *J. Geront.,* 1949, **4,** 222-233.
5. Caldwell, Bettye McD. An evaluation of psychological effects of sex hormone administration in aged women. II. Results of therapy after eighteen months. *J. Geront.,* 1954, **9,** 168-174.
6. Donahue, Wilma. Learning, motivation, education of the aging. In Anderson, J. E. (Ed.), *Psychological aspects of aging.* Washington, D. C.: Amer. Psychol. Ass., 1956. Pp. 200-206.
7. Freeman, H., Parsons, O. A., Feffer, M., Phillips, L., Doneman, E. A., Elmadjian, F., Block, E., Dorfman, R. I., & Pincus, G. Steroid replacement in aged men. *J. clin. Endocrinology & Metab.,* 1956, **16,** 779-789.
8. Glass, S. J., & Shapiro, M. R. Androgen-estrogen treatment in the menopause. *GP,* 1951, **3** (3), 39-42.
9. Hildreth, H. M. Perceptive and intellective abilities. In Anderson, J. E. (Ed.), *Psychological aspects of aging.* Washington, D. C.: Amer. Psychol. Ass., 1956. Pp. 164-167.
10. Kountz, W. B. Revitalization of tissue and nutrition in older individuals. *Ann. Int. Med.,* 1951, **35,** 1055-1067.
11. Mandl, B., & Mensh, I. N. *Psychological factors in diet and hormone research.* Unpublished report, 1954. Available from I. N. Mensh, School of Medicine, U.C.L.A.
12. Masters, W. H., & Grody, M. H. Estrogen-androgen substitution therapy in the aged female. II. Clinical response. *Obstet. Gynec.,* 1953, **2,** 139-147.
13. Rotter, J. B., & Rafferty, J. E. *Manual. The Rotter Incomplete Sentences Blank. College form.* New York: The Psychological Corp., 1950.
14. Sorenson, H. Adult age as a factor in learning. *J. educ. Psychol.,* 1930, **21,** 251-255.
15. Wechsler, D. A standardized memory scale for clinical use. *J. Psychol.,* 1945, **19,** 87-95.

# SOME EFFECTS OF AGE ON SHORT TERM LEARNING AND REMEMBERING*

DENNIS B. BROMLEY, B.A.
*(Department of Psychology, University of Liverpool, England)*

The present investigation examines a number of problems connected with the effects of age on short term learning and remembering in psychiatrically normal adults.

## THE TESTS

### *Auditory Memory*

Auditory memory was defined in terms of scores on the Digit Span test which forms part of the Wechsler-Bellevue Intelligence Scale for Adults (15). It consists of number series that the subject has to repeat either forwards or backwards after hearing them read aloud by the experimenter. Wechsler (16, pp. 83-85), in describing this test, says that it correlates poorly with intelligence tests except at the lower levels. As a test of rote memory it seems to give a quick indication of whether or not the subject has at least enough intelligence to justify further testing. A markedly low Digit Span score may give an early indication of pathology, while a low score on Digits Backwards may indicate lack of mental control and impairment of attention and concentration. The reason Wechsler gives for combining Digits Forwards with Digits Backwards is that the range of scores is thereby increased, and at the same time the contribution of the Digit Span score to the total score is decreased.

Thurstone and Thurstone (12) have shown that Digit Span measures a memory factor but has no loadings on other factors. Rapaport (10), however, rejects the idea that Digit Span is a test of memory in general or memory span in particular, and concludes that more than anything else it reflects the subject's anxiety level, although a large discrepancy between Digits Forwards and Digits Backwards may indicate a psychotic disturbance. Rapaport argues further than the Digit Span test is of no use for differential diagnosis because anxiety is a common feature of most clinical groups. Although anxiety has not been shown to be related to age, yet actual age differences in anxiety might produce results similar to those attributed to age differences in memory span. The fact that all the subjects in the present study were volunteers and free from obvious psychiatric complaints has probably lessened the influence of anxiety as a determinant of Digit Span scores.

So far as the study of age differences in intellectual processes is concerned, the combining of two scores, Digits Forwards and Digits Backwards, into a single score, Digit Span, is unwarranted unless it can be shown that the effects of age are equal for both. Digits Forwards seems to be an almost purely reproductive or reflexive function of short term memory, whereas Digits Backwards seems to be a more complex function involving retention over a longer period of time and some kind of symbolic manipulation. Aging might affect performance on the two tests differently.

### *Visual Memory*

Visual Memory was defined in terms of score on a test of immediate memory for shapes based on Cattell (4, pp. 77-78). The subject is shown a card on which are displayed ten geometrical shapes. After one minute, the card is removed and the subject has to choose from a display of twenty shapes the ones that he thinks were shown to him originally.

It is possible that the short term learning and remembering processes related to the various sense modalities may be differently affected by aging. For example, in older people the memory schemas associated with vision may develop more slowly and decay more quickly than those associated with audition. The Visual Memory test used in the present study was very simple and, like the Auditory Memory test, was not designed to reveal possible differential losses with age in the registration, retention and response phases. Thus, no conclusions can be drawn about the "dynamics" of visual or auditory impairment with age. It was expected, however, that if the older subjects did signif-

* The investigator wishes to acknowledge the advice and criticism tendered by colleagues at the University of Liverpool and elsewhere, while reserving personal responsibility for the report. The investigator is also indebted to Mr. J. E. Fisher, who continues to provide invaluable technical assistance, and to over 250 men and women who took part in the investigations.

icantly less well than the younger subjects on the Visual Memory task, this fact would reflect a definite deterioration with age in the short term learning and remembering processes associated with vision.

The problem was not merely to test for age differences in Visual Memory, but also to test for differences in the rates at which Visual Memory and Auditory Memory change with age.

*Incidental or Latent Learning*

Learning that becomes evident only when the occasion for use arises, and that seems to have been acquired without incentive, intention or reinforcement is frequently referred to as Incidental or Latent Learning. A useful discussion of the problem of incidental learning can be found in McGeoch and Irion (9, pp. 210-215).

There is reason to believe that older people come to rely more and more upon cues which are immediately relevant, and pay less attention to cues with little information content. This means that interesting but merely incidental signals are likely to be ignored. Birren (3) says that there seems to be a narrowing with age of the difference between optimum and maximum levels of performance in the same person. The difference between these two levels can be thought of as a "safety margin," or as a measure of the person's surplus resources. If the total intellectual resources are reduced as age increases, which seems probable, then this impairment is likely to be reflected first of all in a reduction of surplus intellectual resources. It should therefore follow that older people have less ability for making and remembering incidental observations and inferences than comparable younger people. This hypothesis not only opens up a new approach to the study of the differential effects of age on intellectual and learning processes but, if substantiated, would help to account for at least two phenomena of aging: 1) The gradual increase in errors and decrease in successes as tasks become progressively more difficult; and 2) the decrease in quality and originality of intellectual achievement.

Incidental or Latent Learning was defined in terms of score on a test which consisted simply in asking the subject, without his having been warned that he would be asked this question, to describe or recall by name as many as possible of the eleven subtests of the Weschler Bellevue Scale which he had completed a few moments previously. The name of each subtest had been mentioned twice, once before and once after it had been administered. A subject's score was the number of subtests he could remember. This test proved to be too short and too easy. It failed to discriminate adequately between the younger subjects because its upper limit was too low. Thus, although the experimental findings are interesting, they should be interpreted with some caution. They are offered here primarily to indicate a problem rather than to state definite facts about incidental learning.

*Rote Learning*

Tests of Rote Learning tend to be looked upon with disfavor by psychologists interested in the problem of intellectual decline with age because of their so-called "artificiality" or "unsuitability" for older people. This argument is irrelevant from an experimental point of view, since the real problem is to explore, as McClelland has suggested (8, pp. 355-382), the *relational fertility* of the concept of Rote Learning and to discover why, if at all, rote learning tasks are especially difficult for older people.

Two hypotheses were examined: 1) that there are age differences in Rote Learning ability, and 2) that there are age differences in the Serial Position Effect in Rote Learning. (The Serial Position Effect is the tendency for early items in a series to be easier than later items, and for late items to be easier than intermediate ones.) The second hypothesis was put forward by Willoughby (19, 20) as long ago as 1929, but has not been followed up.

Rote Learning was defined in terms of score on a test consisting of twelve nonsense syllables (for example, LON, PEL, LIF) chosen from a list given by Cattell (4, p. 76) and printed in large letters on separate cards. The experimenter exposed the syllables one by one in serial order, and after the first trial the subject went through the list anticipating each syllable and saying it out loud, correcting himself or being corrected by the experimenter whenever he made mistakes. The score was the number of correct anticipations on the eleventh trial. If a subject managed to learn the series, correct to one complete reproduction, in less than eleven trials, he was given an extra credit for each unused trial.

## SUBJECTS

The subjects were volunteers recruited from among acquaintances, casual contacts, local industries, churches, staffs of institutions, social clubs and centers of adult education. Altogether, 256 subjects between the ages of 17 and 82 years were tested, who represented mainly the higher levels of intelligence, education, and socio-economic status. In order to explore age differences in performance, subjects were selected from the pool of 256 persons in such a way as to build up three matched groups which differ in chronological age, but do not differ significantly in age variance, or in mean and variance for Wechsler-Bellevue IQ (Full Scale), Wechsler-Bellevue Vocabulary (Raw Score), and Social Background Rating. Slight modifications were made on some items of the Wechsler-Bellevue test to suit the English culture pattern. The ratings for Social Background were made by the author, and based on educational and occupational history; they ranged from 1 (relatively good) to 5 (relatively poor).

It will be observed in Table 1 that the groups are matched for mean intelligence quotient (IQ), but not for mean efficiency quotient (EQ). The differences in EQ give some idea of the fall off with age in general intellectual efficiency. Thus, the three groups are to be regarded as comparable samples drawn from the same part of the distributions for intelligence at their respective age levels; they are not to be regarded as equal in average intellectual efficiency.

Sex differences on the independent variables were eliminated during the process of selecting matched groups. Statistical tests were made, and where sex differences on the dependent variables (i.e., the test scores) were observed, the results will be given separately for men and women, but not otherwise.

TABLE 1. COMPARISON OF THREE MATCHED AGE GROUPS.

| Age Group | No. | Chronological Age | | Wechsler-Bellevue IQ | | Wechsler-Bellevue EQ | | Wechsler-Bellevue Vocabulary | | Social Background Rating | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X}$ | $s^2$ | $\bar{X}$ | $s^2$ | $\bar{X}$ | $s^2$ | $\bar{X}$ | $s^2$ | $\bar{X}$ | $s^2$ |
| A | 61 | 27.0 | 26.9 | 122.0 | 49.3 | 120.8 | 55.8 | 30.3 | 16.3 | 2.9 | 0.6 |
| B | 71 | 46.5 | 27.0 | 122.6 | 61.9 | 114.6 | 81.5 | 31.3 | 17.7 | 2.8 | 0.9 |
| C | 68 | 66.5 | 26.0 | 120.9 | 62.8 | 105.2 | 94.4 | 31.3 | 21.1 | 2.7 | 0.8 |
| Total | 200 | 47.4 | 279.4[a] | 121.8 | 58.3 | 113.3 | 117.7 | 30.0 | 18.5 | 2.8 | 0.8 |

NOTE.—Observed values of $F_{max}$ and F in analysis of variance tests confirm that the three age groups, A, B, and C, differ significantly in mean age, but are comparable in other ways.

[a] The high value of the total age variance arises from the fact that there was no overlap between the age distributions for the three groups. The inclusive age ranges were 17-35, 36-55, and 56-74 years for groups A, B, and C, respectively.

## RESULTS

The problem of test reliability should not be neglected in studies of aging, as Underwood (13) has recently emphasized. Table 2 shows the coefficients of reliability or internal consistency as computed by the Kuder-Richardson formula described by Walker and Lev (14, pp. 311-314).

The observed reliabilities are not high, although all the correlations are significant at the .01 level (N = 256), with the exception of Incidental or Latent Learning in age groups A and B. These two correlations are not significantly different from zero, a fact accounted for by the test's failure to "spread" the scores of the younger subjects. Accordingly, observed differences between age groups will be conservative estimates, attenuated by errors of measurement. The risk will be that of obscuring a real difference if the null hypothesis is accepted, rather than that of showing a false difference if the null hypothesis is rejected.

Table 3 summarizes the performance of each age group on the various tests, with the results for men and women given separately in some instances. In each case, analysis of variance tests the null hypothesis that the mean scores are the same for each age group.

### *Auditory Memory*

There is little or no evidence for a decline with age on Digits Forwards even for the oldest

TABLE 2. KUDER-RICHARDSON TEST RELIABILITIES.

| Test | m[a] | Age Group[b] | | | Total |
|---|---|---|---|---|---|
| | | A N=61 | B N=71 | C N=68 | N=200 |
| Digits Forwards | 6 | .60 | .66 | .66 | .64 |
| Digits Backwards | 6 | .60 | .68 | .66 | .66 |
| Digit Span | 11 | .76 | .81 | .81 | .80 |
| Visual Memory | 20 | .56 | .54 | .46 | .56 |
| Incidental Learning | 11 | .07 | .14 | .45 | .42 |
| Rote Learning | 12 | .71 | .76 | .75 | .76 |

[a] m = number of items in test.

[b] Group A, mean age = 27.0; Group B, mean age = 46.5; Group C, mean age = 66.5.

TABLE 3. TEST SCORES FOR THREE AGE GROUPS.

| Test | Age Group[a] | N | $\bar{X}$ | Analysis of Variance |
|---|---|---|---|---|
| Digits Forwards (men and women) | A | 61 | 6.8 | |
| | B | 71 | 6.8 | $F=0.16<F_{.95}$ |
| | C | 68 | 6.6 | |
| | Total | 200 | 6.7 | |
| Digits Backwards (men and women) | A | 61 | 5.4 | |
| | B | 71 | 5.5 | $F=5.47>F_{.99}$ |
| | C | 68 | 4.9 | |
| | Total | 200 | 5.3 | |
| Digit Span (men and women) | A | 61 | 12.2 | |
| | B | 71 | 12.2 | $F=2.63<F_{.95}$ |
| | C | 68 | 11.5 | |
| | Total | 200 | 12.0 | |
| Visual Memory (men and women) | A | 61 | 18.8 | |
| | B | 71 | 18.6 | $F=12.98>F_{.99}$ |
| | C | 68 | 17.3 | |
| | Total | 200 | 18.2 | |
| Incidental Learning (men) | A | 30 | 8.5 | |
| | B | 33 | 8.4 | $F=22.31>F_{.99}$ |
| | C | 37 | 6.2 | |
| | Total | 100 | 7.6 | |
| Incidental Learning (women) | A | 31 | 8.8 | |
| | B | 38 | 8.4 | $F=5.47>F_{.99}$ |
| | C | 31 | 7.5 | |
| | Total | 100 | 8.2 | |
| Incidental Learning (men and women) | A | 61 | 8.6 | |
| | B | 71 | 8.4 | $F=25.34>F_{.99}$ |
| | C | 68 | 6.8 | |
| | Total | 200 | 7.9 | |
| Rote Learning (men) | A | 30 | 8.2 | |
| | B | 33 | 8.5 | $F=6.35>F_{.99}$ |
| | C | 37 | 6.2 | |
| | Total | 100 | 7.6 | |
| Rote Learning (women) | A | 31 | 9.5 | |
| | B | 38 | 8.6 | $F_{.95}<F=3.52<F_{.99}$ |
| | C | 31 | 7.4 | |
| | Total | 100 | 8.5 | |
| Rote Learning (men and women) | A | 61 | 8.9 | |
| | B | 71 | 8.6 | $F=9.46>F_{.99}$ |
| | C | 68 | 6.8 | |
| | Total | 200 | 8.0 | |

[a] Group A, mean age = 27.0; Group B, mean age = 46.5; Group C, mean age = 66.5.

age group. The decline on Digits Backwards does not seem to begin before the late fifties. When Digits Forwards and Digits Backwards are combined into the single score, Digit Span, the age differences are altered and statistically insignificant. Thus it would appear from this sample that the single score Digit Span test is a misleading index of normal intellectual decline because it confounds two functions that are affected differently by the process of aging. The discrepancy between Digits Forwards and Digits Backwards increases with age, and this fact should be taken into account when test scores are being used for diagnostic purposes.

*Visual Memory*

Age differences on the test of immediate memory for shapes are negligible between groups A and B, but a significant loss occurs in group C. Even a small loss on such a simple test suggests that aging seriously impairs the processes of short term learning and remembering associated with vision.

*Incidental or Latent Learning*

A test of the significance of the difference between the mean scores of men and women on Incidental Learning gave an observed value of t equal to 2.48, and lying between $t_{.995}$ and $t_{.975}$. The decision to reject the null hypothesis took into account the unreliability of the test.

The combined data for men and women are given in the interests of completeness, but no firm conclusions should be drawn from these combined data, since the samples may represent different populations with respect to Incidental or Latent Learning. On the other hand, the observed difference between men and women is slight, and the effects of age may be seen more clearly when the data are combined. Thus the evidence suggests that on the average women score better than men, and that aging has deleterious effects on Incidental or Latent Learning in both sexes.

*Rote Learning*

A test of the significance of the difference between the mean scores for men and women gave an observed value of t equal to 2.16, and lying between $t_{.995}$ and $t_{.975}$. The decision to reject the null hypothesis took into account the consistent superiority of women on all but one item in the learning series, as shown in Table 4.

The combined data for men and women are given in the interests of completeness but, as noted above, no firm conclusions should be drawn from these combined data, since the samples may represent different populations with respect to Rote Learning. It is clear that aging impairs Rote Learning, especially in later maturity.

*Serial Position Effect.* For low levels of mastery on a Rote Learning task, the early items in the series are easier than the later items, and the late items are easier than the intermediate

TABLE 4. PROPORTIONS OF SUBJECTS PASSING EACH ITEM IN A ROTE LEARNING SERIES.

| Age Group[a] | N | Serial Position Number | | | | | | | | | | | | Average Proportion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| A | 61 | .97 | .87 | .57 | .64 | .62 | .44 | .54 | .61 | .64 | .82 | .90 | 1.00 | .72 |
| B | 71 | .94 | .80 | .52 | .58 | .62 | .51 | .63 | .54 | .58 | .75 | .82 | 1.00 | .69 |
| A + B | 132 | .95 | .83 | .55 | .61 | .62 | .48 | .59 | .57 | .61 | .78 | .86 | 1.00 | .70 |
| C | 68 | .88 | .74 | .47 | .41 | .46 | .50 | .31 | .35 | .43 | .51 | .69 | .93 | .56 |
| Men | 100 | .90 | .80 | .54 | .48 | .51 | .46 | .47 | .42 | .48 | .60 | .75 | .97 | .62 |
| Women | 100 | .96 | .80 | .50 | .60 | .62 | .51 | .52 | .57 | .61 | .78 | .85 | .98 | .69 |
| Total | 200 | .93 | .80 | .52 | 54 | .56 | .48 | .50 | .50 | .54 | .69 | .80 | .98 | .65 |

NOTE.—The proportions are calculated from the numbers of subjects actually passing a given item on the test trial. The average values in the last column are based on these numbers, and therefore do not take into account any extra credit gained by subjects who learned the series in less than the required number of trials.

[a] Group A, mean age = 27.0; Group B, mean age = 46.5; Group C, mean age = 66.5.

ones. Until learning is perfect, the major portion of the dip in the curve is toward the right of the center of the series, and gives a curve which is not symmetrical (9, p. 116).

Table 4 shows the proportions of subjects who had learned a particular item in the series on the test trial.

The numbers of men and women at each age level are approximately the same, so that the small but significant sex difference in mean Rote Learning score can be ignored when Serial Position Effects are being examined.

The proportions of subjects in age groups A and B passing each item were compared, and in no instance was the observed value of Chi-square large enough to be significant. Age groups A and B were then combined in order to give more stable values for proportions passing each item, and in order to simplify comparisons with age group C. When the proportions of subjects in group A + B passing each item were compared with those in group C, values of Chi-square significant beyond the .05 level were observed for items numbered 4, 5, 7, 8, 9, 10, 11, and 12, but not for items numbered 1, 2, 3, and 6.

The analysis of age differences in Serial Position Effect by means of Chi-square is not satisfactory. Although it shows that age differences are present for some items but not for others, it cannot distinguish between (a) serial position effects arising from differences between age groups in the *average* level of difficulty for the series as a whole, and (b) serial position effects arising from differences between age groups in the *particular* level of difficulty of each serial position.

A more satisfactory analysis of age differences in Serial Position Effect can be achieved if Serial Position is regarded as a continuous variable instead of a discrete series, for then the original data of Table 4 can be replaced by equations of the form:

$$Y = a + bx + cx^2$$

where Y is the proportion of subjects passing a given item, and x (i.e., Serial Position) is any value between 0.5 and 12.5. The aim of such equations is to provide better approximations to the true relationships between Serial Position and difficulty level—relationships which are obscured by fluctuations in the original data. Age differences should then stand out more clearly, and the parameters governing average and particular levels of difficulty can be distinguished. It is clear that the equations will hold only within the range for which observations have been made and under the conditions operating at the time. Deductions from the equations will have meaning only for integral values of x. The constants, a, b, and c, can be estimated from the data by the Method of Least Squares (21, pp. 340-365). Appropriate subscripts (for example, $Y_A$, $Y_B$), can be used to distinguish between various subgroups and combinations of, or differences between, subgroups.

The following equations were established:

$$Y_A = 1.3500 - .1937x + .0155x^2$$
$$Y_B = 1.0561 - .1711x + .0138x^2$$
$$Y_{A+B} = 1.0956 - .1824x + .0147x^2$$
$$Y_C = 1.0891 - .2279x + .0175x^2$$

Quadratic parabolas were found to provide a satisfactory fit in each instance. Cubic parabolas did not give more satisfactory solutions. The graphs of equations $Y_{A+B}$ and $Y_C$, together with the observed proportions, are shown in Figure 1.

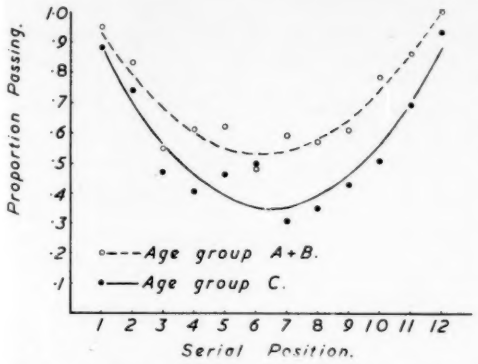


Fig. 1. Age differences in Serial Position Effect for two age groups when $Y = a + bx + cx^2$.

A one-tailed test of the significance of the difference between age group A + B ($\overline{X} = 8.71$) and age group C ($\overline{X} = 6.75$) gave $t = 4.56 > t_{.99}$. There is therefore a significantly lower average level of mastery of Rote Learning in age group C than in the combined age group A + B. This is shown in the graph by the difference in areas under the two curves (.70 and .56 for group A + B and group C respectively). (See also note to Table 4.)

The points of maximum difficulty for the curves in Figure 1 are reached when $\left[\frac{dy}{dx}\right] = 0$, i.e., when the curve attains a minimum. The curve for $Y_{A+B}$ reaches a minimum when $x = 6.22$, and $Y_C$ reaches a minimum when $x = 6.50$. From this it can be concluded that the point of maximum difficulty in the 12-item Rote Learning series occurs at about the mid-point of the series for group A + B, and shifts to the right of center for group C. The amount of shift, however, is not large.

What has been demonstrated so far is that two groups differing in age by an average of 29 years, and differing significantly in Rote Learning ability, produce learning curves which are very similar in shape, which can be described by equations of the same degree, and which have points of maximum difficulty which differ only slightly and in the expected direction. In other words, the effect of aging during the 60's and 70's, in the type of population here considered, is to retard Rote Learning ability but not to disrupt the pattern or method of Rote Learning. This conclusion contrasts with other studies such as those of Welford (17), where aging was shown to produce not only retardation but also changes in the pattern or method of performance.

A more detailed comparison of the two age groups, A+B and C, is possible, in which the particular effects of Serial Position can be shown. This can be done in two ways:

1. Distinguish for the two age groups (a) the parameter governing the *average* level of performance, which is constant for all values of x, and (b) the parameter governing the *particular* effects of Serial Position, which varies with x. Thus, if $\overline{Y}$ is the average level of performance, then $[(a - \overline{Y}) + bx + cx^2]$ is the particular effect of Serial Position, since $Y = \overline{Y}) + [(a - \overline{Y}) + bx + cx^2]$. Therefore $[(a - \overline{Y}) + bx + cx^2]_{A+B} = .3910 - .1824x + .0147x^2$, and $[(a - \overline{Y}) + bx + cx^2]_C = .5324 - .2279x + .0175x^2$.

2. Take $Y_D$ as a measure of age difference, and find an equation:

$$Y_D = (Y_{A+B} - Y_C) = a + bx + cx^2$$

where $Y_D$ is the difference in estimated proportion between the two age groups, and x is Serial Position. As above, in 1, distinguish (a) the parameter governing the *average* difference in proportions passing each item, and (b) the parameter governing the *particular* effects of Serial Position. Therefore $[(a - \overline{Y}) + bx + cx^2]_D = -.1414 + .0455x - .0029x^2$.

The graphs of $[(a - \overline{Y}) + bx + cx^2]$ for age groups A + B and C and their difference, D, are compared in Figure 2. They show how difficulty level varies with Serial Position when the effect of average level of performance has been removed. The Serial Position Effect is

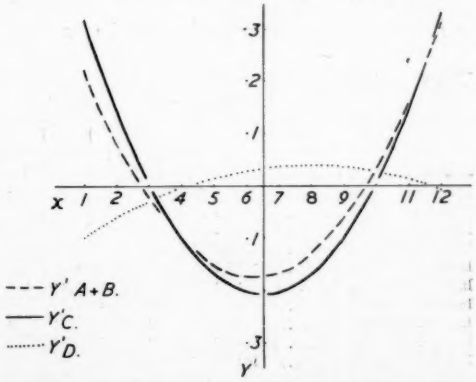


Fig. 2. Age differences in Serial Position Effect when the influence of average level of mastery, $\overline{Y}$, has been removed, and $Y' = (a - \overline{Y}) + bx + cx^2$.

rather more pronounced, and the region of greater *relative* difficulty lies largely to the right of the center of the series for age group C as compared with age group A+B. The age differences in Serial Position Effect, however, are slight, as might be expected when the difference in average levels of performance is not large.

The points of *absolute* maximum difficulty are of course the same as in Figure 1, but the point of maximum *difference*, or the point of *relative* maximum difficulty, is reached at item number 8 in the series. Thus the item of greatest absolute difficulty in a Rote Learning series is not necessarily the item which discriminates most effectively between two age groups. Instead, the most discriminating item lies well to the right of the most difficult item. But it must be noted that this phenomenon could have been produced in two ways: 1) By the failure of the theoretical curves to represent the real relationships between Serial Position and difficulty level. 2) By a true shift to the right of the center of the series in the point of *absolute* maximum difficulty for the group with a lower level of mastery, in this instance age group C.

When the slopes of the two curves, $Y'_{A+B}$ and $Y'_C$ (Figure 2) are investigated mathematically, the point of maximum difference falls at item number 8, where the maximum of $Y'_D$ occurs, thus bearing out the previous analysis.

*Differential Rates of Decline with Age*

Direct comparisons of a provisional kind can be made between the various tests of short term learning and remembering in order to test whether or not aging has any differential effects on the processes underlying the tests. For each test, the mean score for each group is transformed into a standard score, i.e., z score.

TABLE 5. MEAN z SCORES FOR THREE AGE GROUPS AND CORRELATION RATIOS BETWEEN EACH TEST AND AGE.

| Test | N | s | *A | *B | *C | E* |
|---|---|---|---|---|---|---|
| Digits Forwards | 200 | 1.19 | +.03 | +.03 | −.05 | .04 |
| Digits Backwards | 200 | 1.23 | +.14 | +.20 | −.32 | .23 |
| Digit Span | 200 | 2.09 | +.10 | +.13 | −.22 | .16 |
| Visual Memory | 200 | 1.83 | +.30 | +.19 | −.47 | .34 |
| Incidental Learning, Men | 100 | 1.95 | +.46 | +.40 | −.73 | .56 |
| Incidental Learning, Women | 100 | 1.60 | +.34 | +.09 | −.44 | .32 |
| Incidental Learning, Both | 200 | 1.81 | +.40 | +.24 | −.62 | .45 |
| Rote Learning, Men | 100 | 3.18 | +.21 | +.30 | −.44 | .34 |
| Rote Learning, Women | 100 | 3.11 | +.31 | +.03 | −.35 | .26 |
| Rote Learning, Both | 200 | 3.17 | +.26 | +.17 | −.41 | .30 |

* These correlation ratios are significant at the .01 level, with the exceptions of Digits Forwards and Digit Span which are not significantly different from zero, and Rote Learning for women which is significant at the .05 level.

Table 5 shows that the effects of age seem to be different for each test, and that in some cases there appear to be sex differences in the amount of decline.

Estimates of the correlation ratios holding between each variable and age can be computed by taking the square root of the ratio which the sum of the squares between means bears to the total sum of squares. These correlation ratios are given in the final column of Table 5, and provide an alternative way of looking at the same data.

Table 5 reveals several interesting findings:

1. Of the test scores which decline with age, Digits Backwards seems to decline least of all, yet it finds a place in the Wechsler Bellevue test as half a "Don't Hold" subtest, the other half of which, according to the experimental results, does not decline at all. (The investigator proposes to analyze the Wechsler-Bellevue results in detail in the near future. It may be that the differential effects of age in superior samples are rather different from those in average or subnormal samples.)

2. Visual Memory seems to be more seriously impaired by aging than does Auditory Memory. A thorough examination of this possibility would require the construction of parallel and representative tests of Visual and Auditory Memory for use in cross-sectional and longitudinal studies.

3. The age decrement on Incidental or Latent Learning is surprising high relative to the other tests, and taking into account its unreliability. Some of the implications of this finding are discussed in the next section, but it may be pointed out here that these experimental results suggest that Incidental or Latent Learning may prove to be one of the most sensitive indices of age decrement in intellectual performance, and possibly, of course, a sensitive index of intellectual impairment in general.

4. Rote Learning, in spite of its bad reputation as a test for elderly subjects, does not seem to penalize them unduly, although this investigator would not disagree with the observation that older subjects seem to experience a good deal of effort and tension on this test. The apparent sex difference in the effects of age on Rote Learning seems to be similar to that for Incidental or Latent Learning. It would seem that impairment in rote learning ability is not detectable in men until their late 60's, but is detectable in women in their 40's.

5. The fact that the subjects are above the average intellectually probably means that the observed age decrements on the various tests are less than they would have been if average or below average subjects had been studied. On the whole, the score decrements between age groups A and B are slight, and in some instances there are even non-significant increments. The exceptions to this rule occur for women on the tests of Rote Learning and Incidental or Latent Learning. In most instances, the loss with age occurs between age groups B and C. This could imply that the time of onset of decline is later and/or the rate of decline is less for superior subjects than for less well-endowed subjects. Some evidence supporting this implication has been published by Bayley and Oden and by Foulds and Raven (1, 6). The data of the present study are at best only suggestive, and a great deal of additional research will have to be done before the relationships between age decrement and intellectual endowment are made clear.

## DISCUSSION

Welford (17) has shown that within limits older people can compensate for decrements in their performance capacities, but sooner or later the weak components in the intellectual process are no longer able to meet the demands made upon them by a complex task, and the intellectual process as a whole begins to break down. Welford also suggested (18, p. 141) that the key to understanding true learning deficit and a number of other performance decrements with age may lie in some form of short term memory storage of the type dealt with in the present investigation.

Only one topic need be discussed further—the possible relationship between age decrements in Incidental or Latent Learning and intellectual achievement. Many great advances in scientific work and in other areas of human intellectual endeavour have been made by people who observed something interesting, or who had an idea that was not immediately relevant to the problem at hand, or who were alert to unexpected results and relationships. It was as if the problem on which they were working was so far within the limits of their intellectual resources that they had time, interest, and thought enough to spare for making casual observations and inferences, and for dealing with unexpected results. These casual, incidental, or unexpected items of information then became the starting point for a new process of productive thinking.

It has been argued in an earlier section of this report that any age decrement in total intellectual resources arising from physical and mental degeneration is likely to be reflected first of all in a reduction of surplus intellectual resources. These surplus intellectual resources are measured by the difference between the demands imposed by the task and the resources available to the individual. While the ratio of maximum to optimum output is one index of this difference, Incidental or Latent Learning is another. One consequence of the reduction with age in surplus intellectual resources will be the tendency for older people to produce fewer of those happy incidental discoveries, observations, and inferences which contribute so effectively to the development of art, science, and literature. It is clear from Lehman's work (7) that it is the relatively younger person who contributes most frequently both in quantity and quality to human intellectual achievement. The results on Incidental or Latent Learning in the present investigation offer a clue to the understanding of this complex fact.

There may have been some reactive inhibition acting against recall on the test of Incidental or Latent Learning, since one or two subjects were able to recall the names of additional subtests some time later—a kind of reminiscence effect. The poorer incidental recall of the older subjects may have been because of an inability to recall information in words, and not because of an inability to recognize the material, had it been presented to them again. Thus, while incidental verbal recall showed a significant and relatively large decrement with age in the present investigation, incidental recognition was not examined; the latter may be affected by aging to a lesser extent. Belbin (2) has examined this kind of problem. Speakman (11) has studied incidental relearning, but has used an approach rather different from that of the present investigation. Deese (5, pp. 106-109) gives evidence on incidental learning and recall in human beings, and comments on its relationship to studies of latent learning in animals. Recently there has been a renewal of interest in the problem, which provides a large, convenient and fruitful field for research in aging.

SUMMARY

Several tests of short term learning and remembering were administered to matched samples of intellectually superior subjects at three age levels. It was found that:

Digits Forwards did not decline significantly with age, and the slight but insignificant loss on Digit Span was the result of a significant age decrement on Digits Backwards only.

A simple test of immediate memory for geometrical shapes showed that scores declined with age, and it seemed likely that the deterioration associated with normal aging was greater for Visual Memory than for Auditory Memory.

A simple test of Incidental or Latent Learning proved to be very sensitive to the effects of aging. This confirmed the expectation that if the total intellectual resources are reduced as age advances, this reduction will be reflected first of all in a loss of surplus intellectual resources, which govern the capacity for making and remembering incidental discoveries, observations, and inferences. The loss of these resources will reduce the quantity, quality, and originality of the intellectual achievements of older people, and reduce their capacity for productive thinking.

Results for a test of Rote Learning confirmed the expectation that older subjects would do less well on the average than younger subjects. However, the learning process as judged by the Serial Position Effect seemed to be largely unaffected, except that the particular effects of serial position difficulty were slightly more emphasized in the oldest age group, and the serial position which discriminated most effectively between two age groups was well to the right of the region of maximum absolute difficulty.

Sex differences, which usually go unmentioned in studies of aging, were found for two tests, and there seemed to be some indication that men and women might not be affected by aging in precisely the same way.

The amounts of decline with age for the various tests seemed to be dissimilar, but on the whole the amount of decline in early maturity seemed to be negligible when compared with the decline in later maturity.

REFERENCES

1. Bayley, N., & Oden, M. H. The maintenance of intellectual ability in gifted adults. *J. Geront.*, 1955, **10,** 91-107.
2. Belbin, Eunice. The effects of propaganda on recall, recognition and behaviour. II. The conditions which determine the response to propaganda. *Brit. J. Psychol.*, 1956, **47,** 259-270.
3. Birren, J. E. Age changes in speed of simple responses and perception and their significance for complex behavior. Sec. 5, Ch. 8, Experimental studies of changes in performance with age. In International Association of Gerontology, Third Congress. *Old age in the modern world.* Edinburgh: E. & S. Livingstone, 1955. Pp. 235-247.
4. Cattell, R. B. *A guide to mental testing.* London: Univer. of London Pr., 1948.
5. Deese, J. E. *The psychology of learning.* New York: McGraw, 1952.
6. Foulds, G. A., & Raven, J. C. Normal changes in the mental abilities of adults as age advances. *J. ment. Sci.*, 1948, **94,** 133-142.
7. Lehman, H. C. *Age and achievement.* Princeton: Princeton Univer. Pr., 1953.
8. McClelland, D. C. Towards a science of personality psychology. In David, H. P., & von Bracken, H. (Eds.), *Perspectives in personality theory.* New York: Basic Books, 1957. Pp. 355-382.
9. McGeoch, J. A., & Irion, A. L. *The psychology of human learning.* London: Longmans, 1952.
10. Rapaport, D., Gill, M., & Schafer, R. *Manual of diagnostic and psychological testing.* Vol. 1. *Diagnostic testing of intelligence and concept formation.* (Menninger Clin. Monogr. Ser. No. 3) Chicago: Year Book Publishers, 1945.
11. Speakman, D. The effects of age on the incidental relearning of stamp values: the use of deduction in a subsidiary test. *J. Geront.*, 1954, **9,** 162-167.
12. Thurstone, L. L., & Thurstone, Thelma G. Factorial studies of intelligence. *Psychometr. Monogr.*, 1941, **2,** 1-94.
13. Underwood, B. J. *Psychological research.* New York: Appleton-Century-Crofts, 1957.
14. Walker, Helen M., & Lev, J. *Statistical inference.* London: Constable, 1953.
15. Wechsler, D. *Wechsler-Bellevue Intelligence Scale, Form I.* New York: Psychological Corp., 1939.
16. Wechsler, D. *The measurement of adult intelligence.* (3rd ed.) Baltimore: Williams & Wilkins, 1944.
17. Welford, A. T. *Skill and age: an experimental approach.* London: Oxford Univer. Pr., 1951.
18. Welford, A. T. Age and learning: theory and needed research. In *Experientia Supplementum.* IV. *Symposium on experimental gerontology.* Basel: Birkhäuser Verlag, 1956. Pp. 136-143.
19. Willoughby, R. R. Incidental learning. *J. educ. Psychol.*, 1929, **20,** 671-682.
20. Willoughby, R. R. Incidental learning. *J. educ. Psychol.*, 1930, **21,** 12-23.
21. Yule, G. U., & Kendall, M. G. *An introduction to the theory of statistics.* (14th ed.) London: Charles Griffin, 1953.

# THE EFFECTS OF AGE ON CRITICAL THINKING ABILITY

CELIA M. FRIEND, M.A., AND JOHN P. ZUBEK, Ph.D.
*(Department of Psychology, University of Manitoba, Winnipeg, Canada)*

This paper is concerned with developmental changes which occur in one particular type of higher intellectual process, critical thinking ability as measured by the Watson-Glaser Critical Thinking Appraisal Test. Previous research on this ability has been extremely meagre, and the few studies that have been done have dealt for the most part with children and adolescents (4, 5, 13).

A thorough analysis of the nature of critical thinking ability has been carried out by Watson and Glaser. According to them critical thinking "requires that one be able to comprehend and use language for accurate and discriminating communication of thought, recognize the existence (or non-existence) of logical relationships between propositions, interpret data and draw warranted conclusions or generalizations, appraise the adequacy and weight of alleged evidence, weigh it and judge between different degrees of probability of certain conclusions, recognize unstated assumptions, and evaluate arguments" (14, p. 8). Working from this definition, Watson and Glaser have devised a test which seems to be a good measure of critical thinking as defined. This test was used in the present investigation.

The purpose of this study is to answer the following questions: 1) At what age does the peak of critical thinking ability, as measured by this test, occur? 2) When does this ability begin to decline and how pronounced is this decline? 3) What is the course of development and decline of the various subabilities making up critical thinking? 4) Is the pattern of development and decline the same or different for these subabilities?

## THE TEST

The Watson-Glaser Critical Thinking Appraisal Test, Form BM (seventh revision, 1952) was used in the experiment. This test differs considerably from the usual tests designed to measure basic intellectual abilities, such as those measured by the Thurstone Primary Mental Abilities battery or other intelligence test batteries. Correlation coefficients with various intelligence tests tend to cluster around 0.45. This test consists of 99 items almost all of which are of a realistic or practical nature involving problems, statements, arguments, and interpretation of data similar to those which a person might encounter in his daily life as he works, reads the newspaper, hears speeches, and participates in discussions on various topics. The test is usually completed in an hour, although there is no time limit. It contains five subtests. Since the intercorrelations of these five tests cluster around 0.25, the test constructors feel that different facets of critical thinking are being appraised. The five subtests, examples of typical questions, and the abilities which they attempt to measure are as follows:

1. *Inference.* Measures ability to discriminate among degrees of truth or falsity, or to determine the probability of certain inferences being drawn from given facts or data.

Directions: "In this test each exercise begins with a statement of facts which you are to regard as true. After each statement of facts you will find several possible inferences—that is, inferences which some persons might make from the stated facts. Examine each inference separately, and make a decision as to whether it is true, probably true, contains insufficient data, is probably false or false."

Example: A thousand eighth-grade students recently attended a voluntary week-end conference in a Midwestern city. At this conference questions of race relations and means of achieving lasting world peace were discussed, since these were the problems the students felt to be most vital today.

1. As a group, the students who attended this conference had a keener interest in humanitarian or broad social problems than most eighth-grade students have.
2. The majority of these students were between the ages of 17 and 18.
3. The students came from all sections of the country.
4. The students came to discuss trade-union problems.
5. Some eighth-grade students felt that discussion of race relations and means of achieving world peace might be worthwhile.

The investigators wish to express their appreciation to the Department of Veterans Affairs, Ottawa, Canada, for the financial support of this study.

2. *Recognition of Assumptions.* Measures ability to recognize unstated assumptions in given assertions or propositions.

Directions: "Below are a number of statements. Each statement is followed by several proposed assumptions. You are to decide for each assumption whether it necessarily is taken for granted in the statement."

Example: Statement: "We need to save time in getting there, so we'd better go by plane."

Proposed assumptions:

1. Going by plane will take less time than going by some other means of transportation.
2. It is possible to make plane connections to our destination.
3. Travel by plane is more convenient than travel by train.

3. *Deduction.* Designed to measure ability to reason deductively from given premises; to recognize the relation of implication between propositions; to determine whether what seems an implication or necessary inference between one proposition and another is indeed such.

Directions: "Each exercise below consists of two statements (premises) followed by several proposed conclusions. For the purposes of this test, consider the two statements in each exercise as true without exception. Read the conclusions beneath the statements and indicate whether they follow or do not follow. Try not to let your prejudices influence your judgment—just stick to the given statements and judge each conclusion as to whether it necessarily follows from them."

Example: Some holidays are rainy. All rainy days are boring. Therefore—

1. No clear days are boring.
2. Some holidays are boring.
3. Some holidays are not boring.

4. *Interpretation.* Measures ability to weigh evidence and to distinguish between unwarranted generalizations and probable inferences which, though not conclusive or necessary, are warranted beyond a reasonable doubt.

Directions: "Each exercise below consists of a short paragraph followed by several proposed conclusions. For the purpose of this test assume that everything in the short paragraph is true. The problem is to judge whether or not each of the proposed conclusions logically follows beyond a reasonable doubt from the information given in the paragraph."

Example: A sleeping wife was awakened by the sensation of a sharp blow across her mouth. Later that night her husband returned from a fishing trip, his front teeth knocked out by a sharp blow from the oar of his boat. Apparently the husband's accident and the wife's dream came at about the same time.

1. Under the circumstances described there was no way for any ordinary form of direct communication between the husband and wife at the time of the husband's accident.
2. If the facts reported in this case are true, they can be accounted for only by the operation of mental telepathy.
3. The dream was a chance coincidence which was not really influenced by the accident.
4. There are many occurrences in life which we do not understand.

5. *Evaluation of Arguments.* Measures ability to distinguish between arguments which are strong and important to the question at issue and those which are weak and unimportant or irrelevant.

Directions: "Below is a series of questions. Each question is followed by three or four arguments. For the purpose of the test you are to regard each argument as true. The problem then is to decide whether it is a strong argument or a weak argument."

Example: Should all young men go to college?

1. Yes; college provides an opportunity for them to learn school songs and cheers.
2. No; most young men profit more from work experience than from college classes.
3. No; excessive studying permanently warps an individual's personality.

## THE SAMPLE

The Critical Thinking Appraisal Test was administered to a sample of 484 volunteers, representing 64 different occupations and ranging in age from 12 to 80 years. The tests were administered either individually (largely with elderly subjects) or to small groups of two to 15 people. The subjects were obtained from the following sources: friends, friends of friends, schools, university extension courses, church groups and two industrial organizations (Canadian National Railroad and Trans-Canada Airlines). Of the entire sample only ten, all in the over-70 age group, were institutionalized cases. Eight of these were from a home for the aged and two were temporarily in a convalescent hospital. The subjects were for the most part residents of the city of Winnipeg, although 83 tests were given in the cities of Ottawa and Saskatoon. Ten subjects were residents of other Canadian cities, and 19 were from rural points in Manitoba, Saskatchewan and Ontario.

The 64 different occupations engaged in by the subjects can be grouped roughly into five major occupational categories. These categories and the percentage of the total sample in each of them are:

1. Professional (lawyers, clergymen, university professors, pharmacists, high school teachers, social workers, business executives), 15 per cent.
2. Semi-professional (nurses, elementary school teachers, accountants, insurance underwriters, salesmen, lab technicians, small business proprietors, secretaries), 53 per cent.
3. Skilled labor (cabinetmakers, carpenters, machinists, railway engineers, carmen, farmers), 10 per cent.

4. Unskilled labor (caretakers, construction helpers, domestics, waitresses, locker attendants, farm hands), 6 per cent.
5. Students (not presently employed; composed largely of teen-agers), 16 per cent.

Each occupational category was represented, insofar as possible, in the same proportion in each of the various age groups.

Table 1 shows the distribution of 484 subjects according to age, sex, and years of education. It can be seen that each 10-year age group is represented by at least 50 subjects, with the exception of the 70-and-over group where only 35 subjects were tested. Table 1 also shows that the sexes are almost evenly represented in each age group, that the median age for each group approximates the mid-decade mark, and that the subjects in the various age groups have approximately the same educational background (in terms of years of education).

## RESULTS

Each answer sheet was scored by means of a key provided with the test. The raw scores were then converted into T-scores. All graphs are plotted in T-score units.

*Age changes in critical thinking ability.* Figure 1 summarizes the course of development and decline of overall critical thinking and its five subabilities. It can be seen from Figure 1 that critical thinking ability (composite of five subabilities) is not too highly developed in teen-age subjects. However, it develops rapidly thereafter and reaches a peak in the mid-twenties. It then holds up well with age into the mid-thirties, after which it declines steadily through old age.

TABLE 1. DISTRIBUTION OF SUBJECTS BY SEX, AGE AND EDUCATION.

| Age Group | Total Number | Sex M | Sex F | Median Age (yrs. and mos.) | Mean Years of Education |
|---|---|---|---|---|---|
| Teens | 63 | 28 | 35 | 16–11 | 10.5 |
| 20's | 85 | 43 | 42 | 24–7 | 13.7 |
| 30's | 95 | 48 | 47 | 35–0 | 10.9 |
| 40's | 82 | 39 | 43 | 44–7 | 11.4 |
| 50's | 67 | 31 | 36 | 55–3 | 11.4 |
| 60's | 57 | 29 | 28 | 63–9 | 11.6[a] |
| 70 and over | 35 | 11 | 24 | 74–5 | 9.7[b] |
| | 484 | 229 | 255 | | |

[a] Only 28 specified their years of education.
[b] Only 10 specified their years of education.

The remaining Figures show the development and decline of specific subabilities of critical thinking. It can be seen that the ability to evaluate arguments (Figure 2) and the ability to interpret data (Figure 4) both reach a peak in the mid-twenties and then decline immediately. On the other hand, the three subabilities of drawing inferences, detecting assumptions and making deductions all reach their peak some ten years later. Furthermore, differences are evident in the steepness with which these subabilities decline.

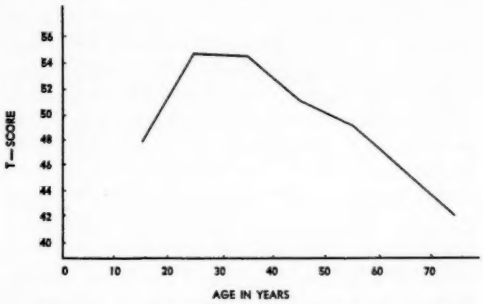


Fig. 1. Age changes in critical thinking ability (composite of five subabilities).

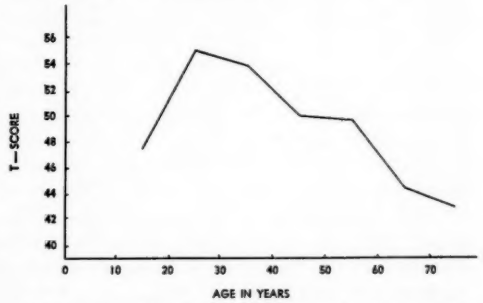


Fig. 2. Age changes in ability to evaluate arguments.

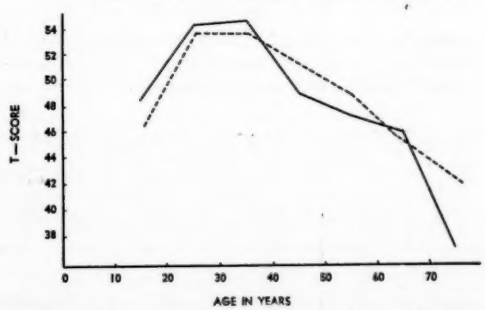


Fig. 3. Age changes in ability to draw inferences (continuous line) and age changes in ability to detect assumptions (broken line).

No statistically significant sex differences were observed on either the whole test or any of the subtests.

*Individual differences.* Table 2 shows the percentage of subjects in the older age groups who obtain scores equal to or greater than the peak mean of 70.34 (raw score on total test) obtained by the 20 to 39 age group. It can be seen that, while the percentages of subjects achieving scores over the peak mean decline with age, there is still a certain percentage of individuals in the oldest age groups who obtain scores as high or higher than this peak. For example, approximately 16 per cent of subjects in their sixties do as well or better than those in their youth. Thus, when individual differences are taken into consideration the decrement in critical thinking in the later years is not so pronounced as it appears at first sight.

*"Flexibility" vs. "inflexibility" in critical thinking.* To ascertain whether any significant differences in "flexibility" or "inflexibility" in thinking existed between the various age groups, the scores for Test 1 (inference) were examined. In this subtest the subject is required to make a choice between different degrees of truth and falsity. The items can be judged true, probably true, false, probably false, or containing insufficient data for making a correct decision. For purposes of statistical analysis the subjects were divided into three age groups: under 25, 35 to 45, and over 60 years, and their answers were grouped into three categories: true or false, probably true or probably false, and insufficient data.

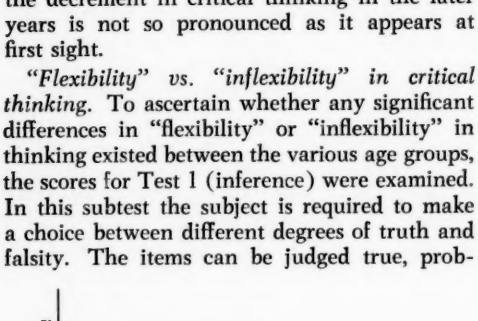


Fig. 4. Age changes in ability to weigh evidence and interpret data (continuous line) and changes in deductive thinking with age (broken line).

Table 2. Subjects Obtaining Scores Equal to or Greater than the Peak Mean.

| Age Group | Number of Subjects | Mean Raw Score | Number over Peak Mean | Percentage over Peak Mean |
|---|---|---|---|---|
| 40's..... | 82 | 65.09 | 23 | 28.0 |
| 50's..... | 67 | 62.19 | 14 | 20.9 |
| 60's..... | 57 | 58.05 | 9 | 15.8 |
| Over 70.. | 35 | 53.31 | 3 | 8.6 |

Note.—Peak mean was 70.34, obtained by the 20-39 age group.

Table 3 shows the mean number of choices made by the three age groups in each of the three categories. It can be seen that the choices of true or false increase with age. This increase is statistically significant. Table 3 also shows that the number of "insufficient data" responses decreases with age as does also the mean number of "probably true or probably false answers." Although the first difference is statistically significant, the second is not.

From these results it would appear that the older subjects are more inclined to choose the absolutes of true and false than to consider other possibilities.

*"Index of objectivity."* A further analysis of the data was made in order to determine whether there are any age differences in the objectivity with which the subjects answered the problems posed in the test. Watson and Glaser (14) have devised an "index of objectivity" which is based on the fact that the test problems are such that they require critical thinking about two different kinds of subject matter. In half the items, the subject is asked to think critically about problems involving "neutral" subject matter such as the weather, scientific facts or experiments, and other things about which people generally do not seem to have strong emotional feelings or prejudices. The other half of the test is composed of items that are approximately parallel in logical structure, but pertain to subject matter involving

Table 3. Choices of Answers on the Test of Inference.

| Age Group | Number of Subjects | Mean Number of Choices | | |
|---|---|---|---|---|
| | | "True" or "False" | "Probably True" or "Probably False" | "Insufficient Data" |
| Under 25. | 110 | 2.97 | 4.17 | 5.60 |
| 35–45.... | 94 | 3.61 | 3.33 | 5.90 |
| Over 60.. | 92 | 4.15[a] | 3.63[b] | 4.23[c] |

[a] Increases statistically significant ($t = 8.43$, $p<.001$).
[b] Decreases not statistically significant ($t = 1.72$, $p>.05<.10$).
[c] Decreases statistically significant ($t = 2.69$, $p = .01$).

political, economic, social and racial issues toward which people are likely to have emotional feelings, biases or prejudices. A lack of objectivity in answering these latter items will reduce the subject's total critical thinking score.

For purposes of statistical analysis the subjects were divided into three age groups: under 25, 35 to 45 years and over 60 years. An index of objectivity for each subject was calculated by dividing his score on the "emotionally loaded" items by his score on the "neutral" items and multiplying by 100. Before doing this, however, it was necessary to identify those items which would most clearly have an emotional loading for the particular group studied (the local Canadian sample) and those items which would not. The identification of these two types of items was achieved by presenting the 99 items of the test to a group of 13 carefully picked local judges, who were required to rate each item for its degree of emotional loading. Using this procedure, fifteen of the most "emotionally toned" and fifteen of the most "neutral" items were identified.

On this index of objectivity, a high score indicates a high degree of objectivity in answering the test questions, and a low score, low objectivity or subjectivity. Table 4 summarizes the results. It can be seen that as age increases there is a progressive decrease in the objectivity with which the subjects answered the test items. The difference in scores between the under-25 age group and the over-60 age group is statistically significant. From this it would appear that the over-60 age group had allowed their emotional feelings, biases and prejudices to influence their decisions to a greater degree than did the younger groups.

## DISCUSSION OF RESULTS

The growth and decline curve of critical thinking ability, as measured by the Watson and Glaser test, is essentially similar in shape to the curves that have been obtained for general intelligence using such tests as the Army Alpha (6), the Otis (9), and the Wechsler-Bellevue (15). However, there is one main difference. Critical thinking ability matures later (in the mid-twenties) and begins to decline later than general intelligence, which reaches a peak in the late teens and early twenties and then immediately begins to decline. This difference might be expected, since critical thinking is an ability which presumably is dependent upon a considerable amount of accumulated experience.

TABLE 4. OBJECTIVITY INDICES FOR THREE AGE GROUPS.

| Age Group | Number of Subjects | Objectivity Index |
|---|---|---|
| Under 25 | 110 | 102.45 |
| 35–45 | 94 | 99.52 |
| Over 60 | 92 | 96.16[a] |

[a] Difference between the over-60 and the under-25 age groups statistically significant ($t = 2.01$, $p > .02 < .05$).

The curve of development and decline of performance on the CTAT, as demonstrated in this study, is also quite similar in shape to those obtained in other studies of intellectual processes. For example, Raven (12), studying subjects ranging in age from 6 to 60 years, found that the "capacity to understand and apply a fresh method of thinking" reaches a peak in the mid-twenties and then slowly declines thereafter. A similar curve of development and decline of the higher thought processes was obtained by Bromley (3), who administered the Shaw test to 256 adults aged 17 to 82. The Shaw test is said to measure creative intellectual output, and involves the mental operations of abstracting, serializing, and productive thinking, and personal qualities of persistence, flexibility, originality, and fluency. Bromley found that the peak years for both quality and quantity of output occurred in the youngest group (mean age, 27 years) and that both quality and quantity declined with age, quality of output declining more rapidly. Finally, Lehman's (8) study of age and achievement in the sciences resulted in a growth curve which showed a rapid rise from the age of 20 to the early thirties, followed by a slow decline to the 45-50 interval, with maximum productivity at 33 and a rapid drop after the age of 55. All of these studies, including the present investigation, seem to indicate that the overall curve of development and decline is very similar for the various kinds of intellectual processes.

The pattern of development and decline of performance on the five subtests of the CTAT was shown to be anything but uniform. This differential pattern of growth and decline is in line with findings of other studies. For example, Jones and Conrad (6) found a differential pattern to occur on the individual subtests of the Army Alpha as did also Berkowitz (2) on the subtests of the Wechsler. Thus it is clear that the specific effect of age on intellec-

tual processes is a function of the particular abilities being studied.

A considerable amount of overlap was found to exist in score distributions from one decade to the next. Essentially the same results were obtained by Miles (10, 11) in the Stanford University Studies in Later Maturity who reported that anywhere from 10 to 25 per cent of those in later maturity and old age did as well or better than those in middle maturity or at their peak.

In any experiment on aging which shows a decrement in performance in the later years, the question always arises as to the possible factors responsible for the decrement. A number of factors are usually mentioned. One is the speed or time factor—the older person cannot work as quickly as the younger person and consequently receives a lower score. This factor was not operative in the present experiment, since an untimed or power test was employed. A second factor often mentioned is poor or faulty motivation on the part of the older subject. It is doubtful whether this variable played any significant role in the present experiment. The subjects were all volunteers, and any individual showing any reluctance or indifference was rejected. Generally speaking, the subjects showed a keen interest in solving the problems, an interest which may be due largely to the nature of the test problems, since they were mostly of a realistic or practical nature dealing with political, economic, social, and scientific issues. The third factor which is often mentioned is a lack of recent practice of the abilities tested. This variable again is not believed to have played too great a part in accounting for the present results; the problems were of the type often encountered in daily life. Furthermore, since most of the subjects were in professional and semi-professional occupations, they had of necessity to use their critical abilities to some degree in carrying out their normal duties.

Finally, there is the question of the sample. In any cross-sectional study this factor is always a very important one. Although great care was taken in the present study to achieve comparability of samples in the different age groups, the possibility exists, nevertheless, that the decrement in performance on the CTAT is partly due to differences in educational opportunity. It was observed that only half of the subjects in the sixties and one-third in the seventies (see Table 1) stated their educational level. This would seem to suggest that the others in these subgroups were probably of lower educational levels. Such an inference, however, is open to some doubts, since 40 per cent of these subjects were in our semi-professional category and would presumably have at least a ninth-grade education. Furthermore, the relatively low correlation of 0.31 between education and performance on the CTAT (obtained on the present sample) suggests that the factor of differences in educational attainment is probably not too important in accounting for the differences in performance. Nevertheless, this factor cannot be dismissed altogether, especially in the over-60 group.

An item analysis of the CTAT revealed that the poorer scores of the elderly subjects were partly due to two factors. The first of these was lower "objectivity" in answering certain types of questions. The second factor was greater "inflexibility"—older subjects in answering certain of the test problems showed a greater tendency to choose the absolute of true or false than to consider other possible alternative answers. This greater inflexibility on the part of older people in choosing among alternatives is a well-known phenomenon in the literature on gerontology. For example, Anderson and Dvorak (1) asked a group of subjects to evaluate various moral issues according to a number of standards, for example, absolute standards of right and wrong, standards of public opinion, and standards set by intelligent judgment. They reported that a very high percentage of middle-aged people made their judgments according to absolute criteria. Similarly, Jones (7), using teachers of different ages, found that the older ones tended to classify various issues according to absolute standards.

From all of this it would seem that emotional and attitudinal factors are partly responsible for the decrement in performance on the CTAT which appears in the later years of life.

## SUMMARY

The Watson-Glaser Critical Thinking Appraisal Test was administered to a group of 484 subjects ranging in age from 12 to 80 years and representing diverse educational, occupational, and economic backgrounds. The main findings are as follows:

1. Critical thinking ability, as measured by this test, shows a progressive increase from late

childhood through to the mid-twenties, holds up to 35 years and then declines progressively through to the seventies.

2. The five subabilities of critical thinking show a differential pattern of development and decline.
3. Although the elderly subjects as a whole have scored poorly on the critical thinking test, many of them still show a high level of performance, a performance as high or higher than young adult subjects.

## REFERENCES


1. Anderson, A., & Dvorak, B. Differences between college students and their elders in standards of conduct. *J. abnorm. soc. Psychol.*, 1928, **23,** 286-292.
2. Berkowitz, B. The Wechsler-Bellevue performance of white males past age 50. *J. Geront.*, 1953, **8,** 76-80.
3. Bromley, D. B. Some experimental tests of the effect of age on creative intellectual output. *J. Geront.*, 1956, **11,** 74-82.
4. Burton, A., & Joel, W. Adult norms for the Watson-Glaser Tests of Critical Thinking. *J. Psychol.*, 1945, **19,** 43-48.
5. Glaser, E. M. An experiment in the development of critical thinking. *Teach. Coll. Contr. Educ.*, 1941, No. 843.
6. Jones, H. E., & Conrad, H. S. The growth and decline of intelligence: a study of a homogeneous group between the ages of ten and sixty. *Genet. Psychol. Monogr.*, 1933, **13,** 223-298.
7. Jones, V. Disagreement among teachers as to right and wrong. *Teach. Coll. Rec.*, 1929, **31,** 24-36.
8. Lehman, H. C. Age and achievement. *Sci. Monthly*, 1945, **61,** 127.
9. Miles, C. C., & Miles, W. R. The correlation of intelligence scores and chronological age from early to late maturity. *Amer. J. Psychol.*, 1932, **44,** 44-78.
10. Miles, W. R. Measures of certain human abilities throughout the lifespan. *Proc. Nat. Acad. Sci. Wash.*, 1931, **17,** 627-633.
11. Miles, W. R. Age and human ability. *Psychol. Rev.*, 1933, **40,** 99-123.
12. Raven, J. C. The comparative assessment of intellectual ability. *Brit. J. Psychol.*, 1948, **39,** 12-19.
13. Watson, G. B. The measurement of fair-mindedness. *Teach. Coll. Contr. Educ.*, 1925, No. 176.
14. Watson, G. B., & Glaser, E. M. *Watson-Glaser Tests of Critical Thinking: manual of directions.* Yonkers, N. Y.: World Book, 1943.
15. Wechsler, D. *The measurement of adult intelligence.* Baltimore: Williams & Wilkins, 1944.

# TASK ALTERNATION TIME IN RELATION TO PROBLEM DIFFICULTY AND AGE*

JACK BOTWINICK, JOSEPH F. BRINLEY, AND JOSEPH S. ROBBIN
*(Section on Aging, Laboratory of Psychology, National Institute of Mental Health)*

There are many terms that describe the ability or inability to alter or modify an ongoing tendency or activity. Several of these terms have been used to hypothesize that older organisms cannot or do not modify ongoing tendencies as readily as do younger ones. Birren (1, 2), for example, has discussed the role of *inhibitory* processes in aging, and in a recent study Botwinick, Brinley and Robbin (5) found evidence for age deficit in motor inhibition. Kay (9) emphasized age decrements in performance that involve *unlearning*, while Heglin (8) found that older persons are both more susceptible to *problem solving set* and have greater difficulty in surmounting its effects. Ruch (14) stressed age deficits in *reorganization of pre-existing* habits, but Korchin and Basowitz (11) maintained instead that the age deficit is in the ability to learn material that is novel. Botwinick, Brinley and Robbin (6), and Korchin and Basowitz (10) found evidence for a decrease with age in the ability to reorganize or *alter prior perceptions*, while Gladis and Braun (7) found age deficits in *retroactive interference*. This last age difference, however, was not found when age groups were equated for vocabulary and learning scores.

These terms have in common a reference to the concepts of *modifiability* or *alteration* of tendencies or activities. In the study here reported, a quantified index of modifiability was derived to test the hypothesis that older persons tend to be less facile in modifying ongoing activity than younger persons, and that this deficit increases with the difficulty of the task. The current interest in the relation between age and performance on tasks of varying difficulty has been reviewed in a recent study (4).

## METHOD

*Subjects.* Two groups of male volunteer subjects were tested. The older group comprised 39 subjects aged 65 to 81, with a median age of 72. The younger group comprised two subgroups of 30 and 28 subjects, with a combined age range of 18 to 32 and a median age of 24.

The range of education in the older group was from 4 to 19 years with a median of 11 years. Two of the 39 subjects were residents in a home for the aged while the remaining 37 were residents in the community. All elderly subjects were examined medically and none was diagnosed as having a psychosis or neurological disorder.

One younger subgroup comprised 30 subjects obtained from personnel of the laboratory and from a group of religious volunteers. The range of education in this younger subgroup was from 12 to 20 years, with a median of 13 years. Although the median years of formal education was not too dissimilar beween this subgroup and the older group, it was thought that the lack of subjects with low levels of education in the younger group might be an important factor. Accordingly, a second group of young but less well-educated subjects was obtained. This subgroup comprised 28 men, selected on the basis of education, all inmates of Patuxent Institution, a modern prison.[1] The range of education for this prison group was from 4 to 10 years, with a median of 8 years of schooling. Only subjects with IQ's between 80 and 120 were chosen. The prisoners were confined for both minor and major offenses.

*Procedure.* Each subject was presented individually with three types of arithmetic tests: a continuous series of problems in addition, a continuous series in subtraction, and a test with alternating addition and subtraction operations.

The addition test was a series of problems that required the subject to add the second digit in the column to the first, add the third digit to this sum, add the fourth digit to this sum, and so on. The subtraction test was similar but required subtraction operations instead of addition. The alternation test was a series of problems that required the subject to sub-

* Grateful acknowledgment is due Dr. Seymour Geisser, Biometrics Branch, NIMH, for statistical advice, and Dr. James E. Birren, Chief, Section on Aging, for helpful suggestions.

[1] The investigators wish to thank Dr. Harold M. Boslow of Patuxent Institution, Jessup, Maryland, for making it possible to collect data in the institution, and Mr. Arthur S. Kandel for his help in scheduling subjects.

tract the second digit in the column from the first, then add the third digit, then subtract the fourth, and so on.

Each of the three types of tests was administered in four levels of problem difficulty. Problem difficulty was defined as the number of arithmetic operations—2, 3, 6, or 9—per problem. Problems of each difficulty level for each type of test were administered either for 2 minutes or for the time just before or after 2 minutes needed to complete the problem. The test was scored in terms of number of operations completed (correctly or incorrectly) in this time. Details of the scoring for the addition problems have been described in a previous study (3).

*Alternation Index.* The Alternation Index (AI) was derived in the following way for each person: 1) The rate of alternation (operations per second) was transformed into its reciprocal. 2) A weighted average arithmetic rate comprising the addition plus the subtraction problems was also transformed into its reciprocal. (This arithmetic rate was derived by weighting the number of subtraction operations to addition operations within a particular difficulty level and then taking an average of the two weighted rates.) 3) The reciprocal of the weighted average arithmetic rate was subtracted from the reciprocal of the alternation rate. The number expressed by this remainder was called the Alternation Index. The AI is in terms of seconds per operation; the higher the index, the more time spent in alternation, and therefore, the poorer the performance.

## RESULTS

The Alternation Index (AI) was computed for each subject for each condition of difficulty. These AI's were analyzed by three types of statistical procedures: an analysis of variance, non-parametric tests, and Pearson product moment correlations.

*Analysis of Variance.* The variances associated with age, with difficulty of task, and with level of education were analyzed. Education was dichotomized into high and low—those with 12 or more years of formal education, and those with less than 12. In order to correct for disproportionate sub-class numbers of subjects (16, pp. 379-391), it was necessary to eliminate two younger subjects in the high education group and one older subject in the low education group. The three subjects eliminated had AI's close in value to the respective sub-class means. Thus the analysis of variance was performed with 19 older subjects and 28 younger subjects in each of the two education groups.

TABLE 1. AGE DIFFERENCES IN ALTERNATION INDEX[a].

| Subjects | DIFFICULTY LEVEL (operations per problem) | | | | All Four Levels |
|---|---|---|---|---|---|
| | 2 | 3 | 6 | 9 | |
| Elderly, 65-81 years N = 39 | | | | | |
| Mean | .36 | 1.68 | 1.78 | 1.91 | 1.43 |
| Median | .17 | 1.03 | 1.44 | 1.39 | 1.12 |
| Young, 18-32 years N = 58 | | | | | |
| Mean | .13 | 1.35 | 1.31 | 1.54 | 1.08 |
| Median | .06 | .92 | .91 | .84 | .78 |

[a] Relative time (in seconds) taken to alternate from one arithmetic operation to another.

While it might seem from Table 1 that the hypothesis of this study was confirmed by these data, the analysis of variance indicated that only the differences between conditions of difficulty were statistically significant ($p < .01$). None of the other variances, including those of age and its interactions, was statistically significant ($p > .05$). These findings suggested that either the hypothesis of this study was incorrect or that there was too much error in the data to demonstrate age differences.

*Non-parametric tests.* The F-ratio involving age indicated a tendency in the hypothesized direction of an age difference in the AI. This, and the extremely large ranges and variances due to several deviant scores, suggested that non-parametric statistics might be more appropriate than parametric statistics to test for differences associated with age and education. The rationale was that the AI is a derived measure of modifiability and it compounds errors associated not only with individual differences but with the effects of the algebraic computations themselves. Mann-Whitney "U" tests (12) were used to determine whether significant differences existed between age groups, between high and low education groups, between high and low education subgroups within the older group and within the younger group, between high education subgroups, and between low education subgroups. For all these tests, the four conditions of difficulty were combined by using the mean of all four AI's for each subject. The "U" tests indicated that both

age and education differences were significant beyond the .01 percent level of confidence. All other tests were significant at $p < .05$, except that which compared elderly and younger subjects within the low education subgroup ($p > .05$).

Clearly, the statistical results of the analysis of variance and of the "U" tests suggest different conclusions. To understand this discrepancy it was necessary to examine closely the distribution of AI's. Those AI's that were high were very high, and in the analysis of variance the magnitude of deviation contributed to the error term. In the "U" tests the high AI's were simply weighted in rank order relation, and magnitude was not a factor.

To determine the significance of interactions by non-parametric statistics it was possible to test only for the interaction between age and education. This was tested in the manner described by Mood (13, pp. 402-403). As was found in the analysis of variance, the interaction was not statistically significant ($p > .05$). It was not possible to test in this way the interaction between age and difficulty because the same individuals were represented in each of the four conditions of difficulty. An interaction, however, was suggested by significant age differences in AI for difficulty levels 6 and 9 ($p < .02$), and by non-significant age differences for levels 2 and 3 ($p > .05$).

*Correlations.* AI's and weighted arithmetic rates were summed across conditions of difficulty and correlated within both age groups. For the younger group, $r = .60$, and for the older group, $r = -.10$. The difference between the two coefficients is statistically significant ($p < .01$). A statistically significant age difference in correlation remained when education level was partialled out. Corresponding correlations for the individual levels of difficulty were low for both age groups.

## DISCUSSION

The Alternation Index, it should be understood, is not an exact or absolute measure of time actually taken to alternate from one type of task to another. The fact that it was found to be largely independent of arithmetic rate adds to its merit as an index of alternation.

The hypothesis of this study was that an older group tends to be less facile in alternating from one operation to another than a younger group, and that this deficit is related to the difficulty of the task. When the data were analyzed by non-parametric statistics, the hypothesis appeared to be tenable.

An additional finding of this study was that when the AI, or the score representing time taken to switch from one arithmetic operation to another, was correlated with a score representing time taken to do the arithmetic operations themselves, there was a larger correlation of these functions in the younger group than in the older one. This suggests that with age there may be something unique about alternation or changing set in that it is relatively independent.

It can be hypothesized and tested in future studies that, with age, this factor of alternation becomes independent or dissociated from other abilities upon which it is dependent or associated in earlier years. A study of this kind should involve more than two age groups or should involve subjects of a large age range, and preferably more than two types of tasks. The hypothesis would demand decreasing correlation with age between the alternation indices and the various abilities that were measured, as well as increased deficits with age in alternation indices.

A related hypothesis is that with age there would be larger correlations between indices of alternation. This would suggest that alternation or set change may be described by both a general factor and specific factors, and that with age, alternation ability becomes more and more a general factor. A study by Schaie (15) suggested that rigidity (a variable similar in some respects to the alternation variable in this study) is best described by three factors; and a study by Wolpert (17) suggested that rigidity is not necessarily generalized from one area to another.

One aspect of the significance of these findings has to do with the representatives of the samples of younger and older subjects. It is the investigators' opinion that if there were a bias in the selection of subjects in this study, it was a bias in the direction contrary to the hypothesis. The older subjects were chosen only after rigorous medical standards were met and they probably represent a group of people physically superior to the average for their age group. In addition, their education level is superior to that of the mean for their age group. On the other hand, the younger subjects who were less than 33 years old and who

have had less than 12 years of schooling may be inferior to the mean for their age group. (It would be, perhaps, a reasonable hypothesis also that the young prisoners were relatively impulsive and would have had difficulty in alternating, since alternation requires the inhibition of one process and the initiation of another.) It is interesting that with the "U" tests no age difference was found in the low education subgroups, but it was found in the high education subgroups. Usually, less marked age differences are shown with highly educated subjects.

## SUMMARY

The aim of this study was to test the hypothesis that an older group is less facile than a younger group in alternating from one type of arithmetic operation to another and that this age difference is related positively to the difficulty of the arithmetic tasks.

Subjects were male volunteers of two age groups, an older group of 39 subjects with a median age of 72 and a younger group of 58 subjects with a median age of 22. Age range, education range, and education median were approximately the same for both age groups.

For each subject an alternation index was derived from arithmetic tasks that were varied in difficulty. There were three types of related findings: 1) an overall age deficit in the alternation index was statistically significant when tested by non-parametric statistics; 2) the alternation index was related to problem difficulty, and there was some evidence that age was a factor in this relationship; 3) in the younger group, but not in the older, speed of arithmetic computation was associated with speed of alternation. The hypothesis suggested by this last finding is that with age a deficit exists in alternating or changing set that is independent of other abilities. A second and related hypothesis is that as alternation abilities become dissociated from other abilities with age they tend to form a general factor rather than to be specific factors as in youth. A study was suggested to test these hypotheses.

## REFERENCES

1. Birren, J. E. Age changes in speed of simple responses and perception and their significance for complex behavior. In International Association of Gerontology, Third Congress. *Old age in the modern world.* London: E. & S. Livingstone, 1955. Pp. 235-247.
2. Birren, J. E. The significance of age changes in speed of perception and psychomotor skills. In J. E. Anderson (Ed.), *Psychological aspects of aging.* Washington, D. C.: American Psychological Association, 1956. Pp. 97-104.
3. Birren, J. E., & Botwinick, J. Rate of addition as a function of difficulty and age. *Psychometria,* 1951, **16,** 219-232.
4. Botwinick, J., Brinley, J. F., & Robbin, J. S. The interaction effects of perceptual difficulty and stimulus exposure time on age differences in speed and accuracy of response. *Gerontologia,* 1958, **2,** 1-10.
5. Botwinick, J., Brinley, J. F., & Robbin, J. S. Modulation of speed of response with age. *J. genet. Psychol.,* in press.
6. Botwinick, J., Robbin, J. S., & Brinley, J. F. Reorganization of perceptions with age. In preparation.
7. Gladis, M., & Braun, H. W. Age differences in transfer and retroaction as a function of intertask response similarity. *J. exp. Psychol.,* 1958, **55,** 25-30.
8. Heglin, H. J. Problem solving set in different age groups. *J. Geront.,* 1956, **2,** 310-317.
9. Kay, H. Learning of a serial task by different age groups. *Quart. J. exp. Psychol.,* 1951, **3,** 166-183.
10. Korchin, S. J., & Basowitz, H. The judgment of ambiguous stimuli as an index of cognitive functioning in aging. *J. Pers.,* 1956, **25,** 81-95.
11. Korchin, S. J., & Basowitz, H. Age differences in verbal learning. *J. abnorm. soc. Psychol.,* 1957, **54,** 64-69.
12. Mann, H. B., & Whitney, D. R. On a test of whether one of two random variables is stochastically larger than the other. *Ann. math. Statist.,* 1947, **18,** 50-60.
13. Mood, A. F. *Introduction to the theory of statistics.* New York: McGraw-Hill, 1950.
14. Ruch, F. The differential effects of age upon human learning. *J. gen. Psychol.,* 1934, **11,** 261-268.
15. Schaie, K. W. A test of behavior rigidity. *J. abnorm. soc. Psychol.,* 1955, **51,** 604-610.
16. Snedecor, G. W. *Statistical methods.* (5th ed.) Ames: Iowa State College Press, 1956.
17. Wolpert, E. A. A new view of rigidity. *J. abnorm. soc. Psychol.,* 1955, **51,** 589-594.

# MOVEMENT TIME, REACTION TIME, AND AGE

WILLIAM R. PIERSON, Ph.D., AND HENRY J. MONTOYE, Ph.D.
*(Michigan State University)*

Increased automation in industry, expanded transportation, and the greater speeds of military and commercial aircraft have emphasized the importance of fast responses. Previous studies with human subjects have in general demonstrated that responses become increasingly slower with advancing age. However, most such studies have been restricted to mature subjects (3, 4, 5, 7, 11, 15) or included only children (8, 10, 16). The studies of Bellis (1) and Miles (12, 13) are exceptions. In some studies (11, 18) the task was complex, involving considerable coordination or thought in solving a problem, and was timed over a considerable length of time; hence fatigue may have been a factor. Such tasks, while perhaps important in certain kinds of employment, may not be similar to the responses required in emergencies such as driving or avoiding a fast moving automobile. Most investigators have not fractioned responses into reaction time (the interval from the onset of the stimulus to the beginning of response) and movement time (the speed of the response itself).

The present study was an attempt to determine the relationship between age and response time in a simple task which required a minimum of learning and of such short duration as not to result in fatigue. The age range included children and old adults, and the response time was separated into reaction and movement times. Accuracy of response was not an important factor, since the task required only a forward movement of the hand through a light beam.

## PROCEDURE

The subjects were 400 males from the Lansing area of Michigan. The sample was stratified so as to include 20 subjects in each of the following age groups: 8, 9, 10, 11, 12, 13, 14, 15, 16, 17-18, 19-20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-55, 56-65, 66-75, and 76-85. The distribution within each age group was such as to favor neither early nor late years. None of the subjects were institutionalized. The young subjects were attending local public schools. The adults were representative of the major occupations in the community except for those subjects beyond age 65, most of whom are retired.

The apparatus consisted of a stimulus unit, a response unit, and a two-chronoscope recording unit which was a modification of the one described by Montoye, Tinkle, Beck and Spiwak (14). A schema of the apparatus is presented in Figure 1.

Each subject was instructed to respond to a neon stimulus lamp by thrusting his hand "as fast as possible" through a light beam. Approximately two seconds after a preparatory set warning, the stimulus lamp and chronoscope were simultaneously activated. When the subject responded to the stimulus by releasing a microswitch, the chronoscope stopped and a second chronoscope was activated. This second chronoscope was stopped when the subject interrupted a photo-electric beam placed 11 inches in front of him. Reaction time was then read from the first chronoscope and movement time from the second. The last 15 of 30 trials were used in the statistical computations.

## RESULTS

The mean scores for each of the twenty age groups appear in Figure 2. An attempt was made to fit a second degree parabola, hyperbola, and logarithmic parabola to these mean scores. The resulting curves did not adequately describe the observed data. Therefore, a smoothed curve was drawn to fit the 400 scores and an index of correlation computed for each of the two relationships (*i.e.*, reaction time and age; movement time and age). An index of correlation[1] was computed rather than a correlation coefficient because the data were curvilinear. The results of these computations, using the entire 400 cases, were indices of .77 for reaction time and .50 for movement time, with standard errors of .02 and .04 respectively. Both indices are statistically significant at the .01 level. It may be seen from Figure 2 that reaction and movement are fastest at about age 20. The curves are very similar, although the

[1] This measure of correlation is a ratio of the variance or scatter around the fitted curve to the variance around the mean of all scores. A detailed discussion of this measure is given by Ezekial (6, chs. 6, 7).

age changes are more pronounced in the case of movement time.

It also seemed important to investigate the relationship between age and consistency of response. To this end, the modal score and the frequency of this mode for each of the 400 subjects were determined. The latter statistic was considered a measure of the consistency of each individual's response and was used in preference to other measures because of its simplicity and ease of calculation. The frequency of the mode was averaged for the 20 subjects in each of the 20 age intervals. The results are presented in Figure 3. An inspection of this figure reveals that in both movement time and reaction time there is an increase in consistency of response with age from eight years until about 30, after which a decline is evident. Although an individual is capable of the fastest response at about age 20, he is most consistent about 10 years later. In the later years, consistency as well as speed declines.

Finally, it was of interest to compare the inter-individual variance of each age group. The results of this analysis are shown in Figure 4. The standard deviations on the ordinate represent a measure of the variation of scores for the 20 individuals in each age group. As can be seen by the plotted points, there is no close relationship in standard deviation and age, except that beyond age 60 the variation between individuals is decidedly greater. Between 15 and 20 years of age, individuals are perhaps most similar in both movement time and reaction time.

## DISCUSSION

A complete response may be fractioned into reaction time and movement time or, as Miles (12) has stated it, "reaction tests" and "motility measures." He concluded that motility measures show much greater deterioration with age than do the reaction tests. The results of the present study, however, show marked differences with age in both measurements. These findings, of course, do not mean that slower responses must nccessarily be a characteristic of aging. It is entirely possible that if people stay more active, some of these and other characteristics of aging may be delayed. There is

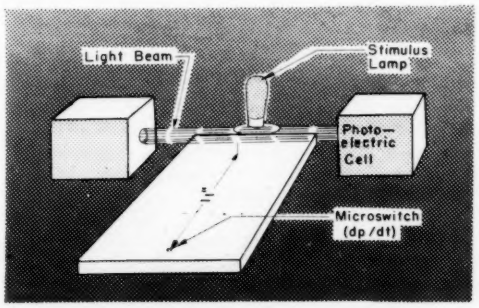


Fig. 1. The apparatus.

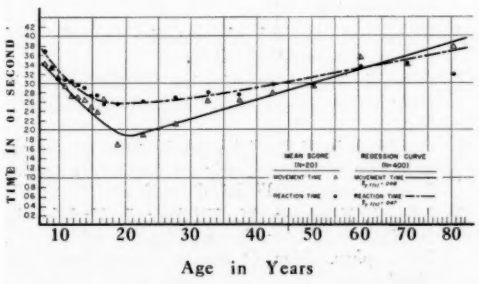


Fig. 2. Smoothed curves for movement time, reaction time, and age, based on group means.

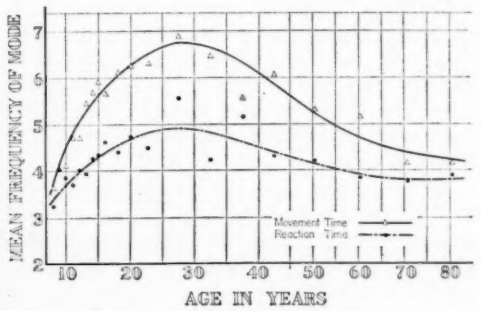


Fig. 3. Relationship between consistency of response and age.

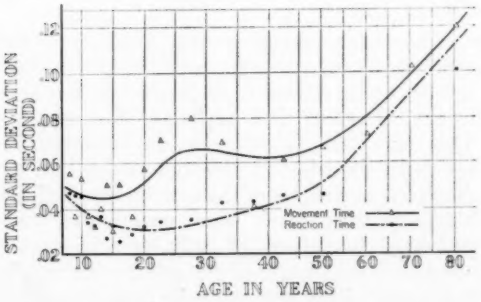


Fig. 4. Variability among subjects in various age groups.

evidence that older people can show remarkable improvements in physical fitness or physical abilities with training (17). There is also evidence that the aging characteristics such as loss of agility, decrease in strength, decrease in endurance, etc., can be delayed with an activity program (9).

In testing movement or reaction time, motivation is a factor to be considered. While this factor was not controlled in the present study, it was our observation that, of the subjects tested, the old people and young children appeared to be most motivated. They seemed eager to learn what their scores were, and to compare them with others. Further evidence that motivation probably is not responsible for the age differences is available in the study by Birren (2) in which the response time of rats to electrical stimulus was studied. The age changes obtained in that study were much the same as those represented in Figure 2. Since the animals were electrically stimulated, it seems likely that the observed changes with age were true age changes and not due simply to decreased motivation among older subjects.

Goldfarb (7) noted a tendency for simple responses to become more variable with age. His data indicated that variability within an individual's responses at ages 35 to 54 was about twice as great as at ages 18 to 44. Goldfarb's results are essentially the same as those in Figure 3.

An interesting aspect of the present study is the increase in inter-individual variance observed in subjects over 60. These results emphasize once again that old people should be treated as individuals; and in terms of employment and other social considerations, should be judged on the basis of their physical and mental capacities rather than on the basis of chronological age.

It has been pointed out by Singleton (18) that age changes in movement and reaction speeds can be related to underlying differences in central rather than peripheral functioning. This may well be true in the experiments which he described. Compared to the task in the present experiment, the activities studied by Singleton were much more complicated and prolonged. In the present study, once the movement had been initiated the speed with which it was carried out was markedly slower in older people. This slowness may be due to biochemical or mechanical changes in the contractile elements (peripheral functions), but it could also be due to changes in the central nervous system.

## SUMMARY

Movement and reaction time in 400 male subjects aged 8 to 83 were measured by a fractioning process employing two chronoscopes. An analysis of the relationships between age and response time led to the following conclusions:

1. Movement time and reaction time are significantly related to chronological age, although in neither case does a simple mathematical equation express this relationship. In both speed of reaction and movement, fastest responses were recorded in the early twenties.
2. Consistency of response, as measured by the frequency of the modal score for each subject, was greatest at approximately 30 years of age.
3. Beyond the age of 60, the inter-individual differences in reaction and movement time increased greatly as compared with those of younger subjects. This relationship with age is curvilinear.

## REFERENCES

1. Bellis, C. J. Reaction time and chronological age. *Proc. Soc. Exper. Biol. & Med.*, 1933, **30,** 801-803.
2. Birren, J. E. Age differences in startle reaction time of the rat to noise and electric shock. *J. Geront.*, 1955, **10,** 429-432.
3. Birren, J. E., & Botwinick, J. Age differences in finger, jaw, and foot reaction time to auditory stimuli. *J. Geront.*, 1955, **10,** 429-432.
4. Birren, J. E., & Botwinick, J. Speed of response as a function of perceptual difficulty and age. *J. Geront.*, 1955, **10,** 433-436.
5. Botwinick, J., Brinley, J., & Birren, J. E. Age differences in reaction time readiness. *J. Geront.*, 1955, **10,** 472.
6. Ezekial, M. *Methods of correlation analysis.* (2nd ed.) New York: Wiley, 1941.
7. Goldfarb, W. An investigation of reaction time in older adults. *Teach. Coll. Contr. Educ.*, 1941, No. 831.
8. Goodenough, F. L. The development of the reactive processes from early childhood to maturity. *J. exp. Psychol.*, 1935, **18,** 431-450.
9. Jokl, E., Karvonen, M., Kihlberg, J., Koskela, A., & Noro, L. Research on Olympic athletes. *J. Hlth., phys. Educ. & Recreat.*, September, 1956, 61-62.
10. Jones, H. E. Reaction time and motor development. *Amer. J. Psychol.*, 1937, **50,** 181-194.

11. Miles, W. R. Correlation of reaction and co-ordination speed with age in adults. *Amer. J. Psychol.*, 1931, **43,** 377-391.
12. Miles, W. R. Measures of certain human abilities throughout the life span. *Proc. Nat. Acad. Sci.*, 1931, **17,** 627-632.
13. Miles, W. R. Psychological aspects of aging. In E. V. Cowdry (Ed.), *Problems of ageing.* Baltimore: Williams & Wilkins, 1942.
14. Montoye, H. J., Tinkle, W., Beck, B., & Spiwak, B. An electronic track and reaction timer. *F.I.E.P. Bull.*, 1956, **26,** 1-6.
15. Obrist, W. D. Simple auditory reaction time in aged adults. *J. Psychol.*, 1953, **35,** 259-266.
16. Philip, B. R. Reaction-times of children. *Amer. J. Psychol.*, 1934, **46,** 379-396.
17. Sigerseth, P. O. Some effects of training upon young and middle-aged men. *Res. quart.*, 1951, **22,** 77-83.
18. Singleton, W. T. Age and performance timing on simple skills. In International Association of Gerontology, Third Congress. *Old age in the modern world.* London: E. & S. Livingstone, 1955. Pp. 221-231.

# RIGIDITY FACTORS IN THE TESTING OF MIDDLE-AGED SUBJECTS*

GORDON L. MANGAN, Ph.D., AND JAMES W. CLARK
*(Department of Psychology, Queen's University, Kingston, Ontario)*

Prior learning may inhibit performance on a new task. This inhibition or negative transfer enters into many psychological phenomena and there are marked individual differences in the amount of inhibition shown. To account for such differences, a source trait of rigidity has often been postulated. It has been suggested that the decline in performance of older people on a variety of cognitive, motor, and perceptual tasks is due in part to an increase in this trait with age.

The nature and structure of a rigidity factor or factors which may be reflected in negative transfer situations is unclear. Factorial evidence on this point is limited. A factor analytic study by Oliver and Ferguson (4) indicated that tests of cognitive rigidity — problem-solving tasks which required the subject to perform an overlearned cognitive operation in an unaccustomed manner — defined a factor which could be clearly differentiated from factors involved in other tests of mental abilities. This cognitive rigidity factor was found by Scheier and Ferguson (6) to be independent of tests involving the performance of overlearned motor tasks in an unaccustomed manner. On the other hand, however, more recent research by Scheier (5) suggests that there may be no specific rigidity component in the cognitive and motor rigidity tests used by these investigators. Scheier concluded that such tests are largely measures of other clearly defined factors like reasoning and motor speed.

In these three studies, Ss were all college students. Even if cognitive rigidity is subsumed under other mental ability factors with young Ss, it is quite possible that such a factor might emerge clearly among older Ss. The present study is an attempt to identify a rigidity factor of this type through a group of middle-aged Ss, to measure the percentage of the variance of reasoning test scores accounted for by such a factor, and to investigate its comprehensiveness. For this purpose, we have broadened our definition of rigidity to include the interfering effects of experimentally induced set (Einstellung).

This research was supported by a grant from the Department of Veterans' Affairs, Ottawa.

## METHOD

A factor analysis was performed on three cognitive rigidity (Einstellung) tests, four non-cognitive rigidity tests (which were included in the battery for control purposes), and four reasoning tests.

### *The Tests*

*The four reasoning tests: Letter Series I, Number Series I, Verbal Analogies, and Gottschaldt Figures.* The Gottschaldt Figures test was from the Cattell Objective-Analytic Personality Test Batteries (1). S was required to indicate the two of four complex figures which contain a simpler figure. The others were from the Thurstone Primary Mental Abilities (PMA) Battery (7). They are well known and require no description here.

*The three cognitive rigidity (Einstellung) tests: Letter Series II, Number Series II, and Letter Grouping II.* These tests consisted of 25 items arranged in 5 cycles of 5 items each. Each cycle involved a distinct principle of classification, i.e., the method which solved items 1-5 would not solve items 6-10. S's instructions were that in each item letters or numbers or groups of letters were arranged in series. He was to write in the appropriate spaces the next letter or number or, in the case of Letter Grouping II, to mark the group which differed from the others in some respect. No items were to be omitted, and S had to be sure, before going on to the next item, that he understood the principle involved in the solution he was presenting. After each item S was to note down the time. (The experimenter displayed successive numbers at 5-second intervals. S, on completion of each item, wrote in the space provided after each item the number being displayed.) In this way the test items were individually timed.

The rigidity or Einstellung score was measured as the ratio of time required to solve the problem when a new principle was involved to the time required to solve the remaining four items in the cycle.

Sample items from Letter Series II are:

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | a | a | b | b | c | c | d | ... | ... | | | ( | ) |
| 2. | f | f | f | g | g | g | h | h | h | ... | ... | ( | ) |
| 3. | j | j | k | k | l | l | m | m | ... | ... | | ( | ) |
| 4. | m | m | m | m | n | n | n | n | o | o | ... | ... | ( | ) |
| 5. | p | p | q | q | r | r | s | s | ... | ... | | ( | ) |
| 6. | c | d | e | e | f | g | h | h | ... | ... | | ( | ) |

Sample items from Letter Grouping II are:

| | | | | | |
|---|---|---|---|---|---|
| 1. | ABAA | GJBA | AATA | GAAA | ( ) |
| 2. | XXOF | XPTX | XRGT | XFXL | ( ) |
| 3. | LMGL | MCRL | CLSL | LNLU | ( ) |
| 4. | POLM | POPB | NPPS | SPUP | ( ) |
| 5. | GHGG | NGGG | MGIG | GRGG | ( ) |
| 6. | ABCD | FGHI | KLMO | RSTU | ( ) |

*The two motor rigidity tests: Backward Writing and Two Hand Co-ordination.* The Backward Writing test is from the Cattell Objective-Analytic Personality Test Batteries (1). The score was the ratio of the speed of backward writing to the speed of forward writing.

The Two Hand Co-ordination test was adapted from Thurstone (8). The material consisted of a number of small blue, red, green, and yellow blocks which were placed in a box in front of S. Immediately in front of S two circles, about 8 inches in diameter, were drawn side by side. The circles were divided into four sectors and each sector was labelled with a small piece of blue, red, green, or yellow paper. The order of the sectors was different in the two circles.

The test was given in three parts. In the first part of the test S was asked to place, with his right hand, as many blocks as possible on the matching colored sectors of the right-hand circle. Only one block was to be picked up at a time, and the blocks were to be placed in clockwise rotation as rapidly as possible. S was given one or two preliminary trials to make sure he understood the nature of the task. The total number of successes in the 15-second test period was recorded. In the second part of the test S was asked to do the same task with his left hand, using the left-hand circle, and placing the blocks in counterclockwise rotation. In the third part of the test S placed pairs of blocks, one in each hand, in their correct sectors of the right- and left-hand circles as rapidly and as accurately as possible.

The score on this test was $\frac{N_{r1}}{N_r + N_l}$, where $N_r$ and $N_l$ were the number of blocks placed in 15 seconds for the right and left hands alone, and $N_{r1}$ the number of blocks placed with the two hands together in 15 seconds.

*The two perceptual rigidity tests: Gestalt Closure and Hidden Objects.* Both tests are from the Cattell Objective-Analytic Personality Test Batteries (1). The Gestalt Closure test is scored as the number of incomplete pictures correctly recognized. In the Hidden Objects test a number of familiar objects are concealed in a drawing. The score is the number of these objects found.

### *Procedure*

The test battery was administered in two sessions of approximately one hour each to 50 Ss—30 women and 20 men—in the age range 40–55 years. All Ss were English-speaking, literate, and gainfully employed at the time of testing. The sample can be roughly described as middle-class. Three groups of approximately 17 Ss each were given the tests in exactly the same order and under uniform conditions of timing and instructions.

## RESULTS

### *Analysis of the Data*

Product-moment intercorrelations between the 11 variables were calculated. These intercorrelations are shown in Table 1.

Four factors were extracted by the centroid method from the 11 x 11 correlation matrix. Extractions were continued until the product of

TABLE 1. THE ORIGINAL CORRELATION MATRIX FOR ELEVEN TESTS.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Letter Series II | (51) | | | | | | | | | | |
| 2. Number Series II | 51 | (57) | | | | | | | | | |
| 3. Letter Grouping II | 44 | 28 | (44) | | | | | | | | |
| 4. Gestalt Completion | 22 | 22 | 12 | (45) | | | | | | | |
| 5. Hidden Pictures | 28 | 38 | 20 | 45 | (45) | | | | | | |
| 6. Gottschaldt Figures | 33 | 18 | 29 | 26 | 17 | (44) | | | | | |
| 7. Analogies | 39 | 40 | 25 | 24 | 36 | 43 | (56) | | | | |
| 8. Number Series 1 | 41 | 43 | 40 | 20 | 33 | 42 | 56 | (79) | | | |
| 9. Letter Series 1 | 50 | 46 | 23 | 28 | 39 | 44 | 37 | 79 | (79) | | |
| 10. Two Hand Coordination | 31 | 12 | 11 | 23 | 18 | 19 | 21 | 22 | 24 | (31) | |
| 11. Backward Writing | 22 | 20 | 11 | 16 | 15 | 22 | 15 | — | 12 | 25 | (25) |

NOTE.—Decimals omitted throughout.

the two highest centroid loadings (.10) did not differ appreciably from the standard error of the original correlation between the two variables (.14). The centroid factor matrix is shown in Table 2.

The centroid factors were rotated into an orthogonal simple structure. Six graphical 2 x 2 rotations were necessary to stabilize the factors in the rotated matrix. Factor 2 came out as a comprehensive general factor. An attempt was made to test its generality by unloading as much of its variance as possible onto the minor factors. The rotated factor matrix is shown in Table 3.

### *Interpretation of the Factors*

FACTOR 1. REASONING

| *Test No.* | *Name* | *Content* | *Loading* |
|---|---|---|---|
| 8. | Number Series I | Reasoning | —.60 |
| 9. | Letter Series I | Reasoning | —.54 |
| 6. | Gottschaldt Figures | Reasoning | —.35 |
| 7. | Analogies | Reasoning | —.28 |

Factor 1 loads exclusively on reasoning tests, and is identical with the reasoning factor identified by Thurstone and others through the same tests. Reasoning accounts for 8 per cent of the total variance.

FACTOR 2. GENERAL ATTITUDE FACTOR

| *Test No.* | *Name* | *Content* | *Loading* |
|---|---|---|---|
| 1. | Letter Series II | Cognitive Rigidity | .74 |
| 8. | Number Series I | Reasoning | .67 |
| 2. | Number Series II | Cognitive Rigidity | .66 |
| 7. | Analogies | Reasoning | .61 |
| 9. | Letter Series I | Reasoning | .58 |
| 3. | Letter Grouping II | Cognitive Rigidity | .56 |
| 6. | Gottschaldt Figures | Reasoning | .42 |
| 5. | Hidden Pictures | Perceptual Rigidity | .43 |
| 4. | Gestalt Completion | Perceptual Rigidity | .30 |
| 10. | 2-Hand Coordination | Motor Rigidity | .30 |
| 11. | Backward Writing | Motor Rigidity | .25 |

This factor, which accounts for an average of 28 per cent of the variance, loads significantly on 10 of the 11 tests in the battery, but is involved more particularly in the cognitive rigidity (Einstellung) and reasoning tests. It cannot be identified with any kind of general ability factor, both because of its orthogonality to reasoning factor 1, and because it loads significantly on tests (Hidden Pictures and Gestalt Completion, for example) which probably do not involve problem-solving ability. In view of its comprehensiveness it is just as obviously not a cognitive rigidity factor and is perhaps best described as a general "attitude-to-test-taking" factor, which is probably a composite of a cognitive rigidity or Einstellung factor, of the general anxiety and apprehension of middle-aged Ss in the test situation, and of their unfamiliarity with test materials. As such, it falls into the general category of method-of-approach factors, such as persistence, speed, carefulness, and so on, which are partly expressed through the form of the test items and the conditions under which tests are administered (2, 3).

Factors 3 and 4, which account respectively for an average of 5 and 7 per cent of the variance, are clearly motor and perceptual rigidity factors.

## SUMMARY AND CONCLUSIONS

A battery of eleven tests, seven of which were cognitive (Einstellung), perceptual, and motor rigidity tests, and four of which were PMA and Cattell reasoning tests, were administered to a sample of 50 Ss aged 40–55 years. Four centroid factors were extracted from the 11 x 11 correlation matrix and were rotated into an approximation to simple structure.

Factor 1 stands out clearly as a reasoning factor. Factors 3 and 4 are unambiguous and easily identifiable as minor factors of motor and

TABLE 2. THE CENTROID FACTOR MATRIX: RAW FACTOR LOADINGS.

| Test | $K_1$ | $K_2$ | $K_3$ | $K_4$ |
|---|---|---|---|---|
| 1. Letter Series II | 67 | 19 | 16 | −25 |
| 2. Number Series II | 60 | 13 | −19 | −28 |
| 3. Letter Grouping II | 47 | 04 | 20 | −30 |
| 4. Gestalt Completion | 46 | 20 | −17 | 33 |
| 5. Hidden Pictures | 54 | 21 | −41 | 14 |
| 6. Gottschaldt Figures | 55 | −22 | 24 | 15 |
| 7. Analogies | 64 | −15 | −05 | −14 |
| 8. Number Series 1 | 74 | −47 | −15 | −17 |
| 9. Letter Series 1 | 75 | −31 | −14 | −11 |
| 10. Two Hand Coordination | 39 | 14 | 18 | 19 |
| 11. Backward Writing | 30 | 29 | 22 | 18 |
| Average per cent variances accounted for | 32.7 | 5.7 | 4.4 | 4.6 |

NOTE.—Decimals omitted throughout.

TABLE 3. THE ROTATED FACTOR MATRIX.

| Test | $K_1$ | $K_2$ | $K_3$ | $K_4$ |
|---|---|---|---|---|
| 1. Letter Series II | 09 | 74 | 13 | 00 |
| 2. Number Series II | 01 | 66 | −18 | 16 |
| 3. Letter Grouping II | 04 | 56 | 08 | −17 |
| 4. Gestalt Completion | −08 | 30 | 18 | 51 |
| 5. Hidden Pictures | −08 | 43 | −10 | 57 |
| 6. Gottschaldt Figures | −35 | 42 | 36 | 00 |
| 7. Analogies | −28 | 61 | −01 | 05 |
| 8. Number Series 1 | −60 | 67 | −12 | −02 |
| 9. Letter Series 1 | −54 | 58 | 07 | 22 |
| 10. Two Hand Coordination | −01 | 30 | 35 | 17 |
| 11. Backward Writing | 16 | 25 | 37 | 18 |
| Average per cent variances accounted for | 8.1 | 27.8 | 4.6 | 6.8 |

NOTE.—Decimals omitted throughout.

perceptual rigidity. Factor 2 remains large, despite strenuous efforts in the rotations to unload variance onto the other factors. The criterion variables for this vector are the cognitive rigidity tests and three of the four reasoning tests. It is interesting to note that all the reasoning tests load more heavily on this factor than they do on reasoning factor 1. The factor is identified as a general "attitude-to-test-taking" factor, which seems very like the inverse of a sophistication factor so clear among younger Ss.

It is clear that with this sample, under the stated conditions, most of the variance of the reasoning tests is accounted for by this general attitude factor, and not by a reasoning factor—i.e., reasoning tests such as PMA letter series ranked our Ss primarily on their adaptability to test conditions, rather than on their ability to solve reasoning problems of this type.

It is suggested that the administration of a similar battery of tests to a younger sample might result in the emergence of a clear cognitive rigidity (Einstellung) factor, on which the reasoning tests might be expected to show a more modest loading.

## REFERENCES


1. Cattell, R. B. *The Objective-Analytic Personality Test Batteries.* Champaign, Ill.: Inst. Pers. Ability Testing, 1955.
2. Eysenck, H. J. *The scientific study of personality.* London: Routledge & Kegan Paul, 1952.
3. Mangan, G. L. Method-of-approach factors in the testing of middle-aged subjects. *J. Geront.*, 1958, **13,** 55-59.
4. Oliver, J. A., & Ferguson, G. A. A factorial study of tests of rigidity. *Canad. J. Psychol.*, 1951, **5,** 49-59.
5. Scheier, I. H. An evaluation of rigidity factors. *Canad. J. Psychol.*, 1954, **8,** 157-163.
6. Scheier, I. H., & Ferguson, G. A. Further factorial studies of tests of rigidity. *Canad. J. Psychol.*, 1952, **6,** 18-30.
7. Thurstone L. L., & Thurstone, T. G. *Primary Mental Abilities Test.* Chicago: Sci. Res. Associates, 1947.
8. Thurstone, L. L. *A factorial study of perception.* Chicago: Univer. of Chicago Pr., 1944.

# BOOK REVIEWS

*Services for the Aging.* EDITED BY IRVING L. WEBBER. Gainesville: University of Florida Press, 1957. Pp. 159. $2.50.

This volume contains fifteen papers on services for the aging presented at the Seventh Annual Conference on Gerontology, held at the University of Florida in March, 1957.

The papers cover public and private services in public welfare, health, employment, recreation and education, home care, foster home care, counseling, and rehabilitation. Although the programs described vary widely in stage of development, comprehensiveness, and types of persons being served, structure for the book is provided by the editor's lucid preface explaining the framework of the conference and summarizing the papers; and by organization of the papers into: 1) General introduction, 2) Community services, 3) Services in the home, 4) Services in the institution, and 5) Conference summary.

Four major points are emphasized. First there is a shift from broad, general approaches to older people to a consideration of individual needs. Second, there is a shift from institutional treatment to treatment in the home. Third, there is growing emphasis on a preventive approach to problems of aging, including the need for educational programs to alter rejecting attitudes toward the aged. Fourth, there is need for coordination of the multiple services described. Those concerned over the latter point may be heartened by an observation true of the mental health field, where a similar state exists, that a period of mushrooming and confusion may be necessary before coordination of services can be achieved.

The literature on services to the aging is scattered, and there is need for treatment of the subject as a whole. While this volume is not intended to provide a complete coverage—for example, it gives scant attention to day-care and day-centers—it provides a compilation and description of diverse services, together with their assessment, description of goals, and consideration of next steps. As such, it is a useful contribution to gerontological literature.

MARGERY J. MACK
Social Science Consultant
Mental Health Service
Department of Health, Education, and Welfare

*Free Time: Challenge to Later Maturity.* EDITED BY WILMA DONAHUE, WOODROW W. HUNTER, DOROTHY H. COONS, AND HELEN K. MAURICE. Ann Arbor: University of Michigan Press, 1958. Pp. 172. $4.50.

The tenth annual conference of the Institute of Gerontology at the University of Michigan was devoted to an inquiry into free time as a major challenge of the later years of life. The present book is a selection of papers given at that conference.

The importance of this book stems from the place of social gerontology as a bridge between the theoretical and the applied social sciences, as well as between science and ethics. Thus is seems natural to find contributions here by several sociologists, psychologists, an anthropologist, an historian, and also a foundation executive and a religious scholar.

After a preface by Clark Tibbitts, one which sets the theme for the volume, Rosalie Wax, an anthropologist, leads off. The concept of leisure is examined in light of the cultures of African Bushmen, Plains Indians, a Pakistani tribe, and the medieval Jew. In our own culture, she views play as freedom, a potential for a democratic "community of interest."

John Anderson, in his "Psychological Aspects of the Use of Free Time," sees the major problem as that of designing activities which give to older persons the same type of personal results as did their work activities. This thesis may be questioned, but it deserves well-designed research studies to examine the refinements suggested in such variables as personality differences.

The limitations of a short paper do not explain the failure of Rolf B. Meyersohn to delve more deeply than he does into the concept of leisure. His paper moves too quickly into drawing distinctions between leisure-time patterns of older and younger generations without successfully relating this to his first theme.

A substantive contribution is Maurice E. Linden's "Preparation for the Leisure of Later Maturity." The issue he raises is that of ends—a model for an "enriched sense of living" viewed in terms of social relationships. This leads him to the nature of mental health, which he characterizes in several ways such as "the ability to initiate independent action" and "a sense of purposefulness." Linden closes with an interesting classification of leisure activities and another of the effects of activities.

A forceful statement is made by Robert J. Blakely of the (Ford) Fund for Adult Education. He observes that "most of our old people lack the personal capacities to deal with old age," and turns to the failures of education to meet this predicament: our confusing of education with school, our idolatry of work, our cult of youth. These are familiar themes, but seldom put more succinctly.

Eugene A. Friedmann performs a service for those of us who like to use the "ideal construct" approach. He sets up a picture of retirement in three periods, that before 1950, in the decade 1957-1967, and the future. Three themes are explored in each: the nature of retirement itself, economic factors, and attitudes toward work and leisure.

With Leroy Waterman's paper I must take sharp issue. It was wise for the Michigan planners to invite a paper dealing directly with a most central issue in the discussion of leisure, the nature of the "good life." The opportunity for a penetrating analysis was forfeited, however, in this paper in which religion is equated with "human personality," religion is seen as the only life instrumentality that always makes the conscious attempt to view life as a whole in relation to its total environment, and perhaps more serious, in which the association only of Jesus is made with that instrumentality.

The problem of creativity is treated by Harold Anderson, the psychologist. In view of the difficulty of finding objective criteria, he proposes that creativity be studied as a social process; further, that it cannot be

understood in relation to all ages. His concluding discussion deals with the question, At what cost in spontaneity or self-expression have people learned to live harmoniously in their culture? This issue of the relations between leisure as relative non-commitment to current values and to social controls brings us (in the reviewer's opinion) to the kind of questions which cry for detailed analysis.

There are other worthwhile papers. Clark Tibbitts, in his own contribution, indicates reasons for the increased number of middle-aged and older people. With the increased productivity of our society, these persons can afford leisure; but the problem arises—whether or not it will be wisely used. Economic reasons for the growth of a labor force are discussed by George Soule. The distinguished sociologist, Ernest W. Burgess, presents a short statement of principles for organizations of retired persons. C. Hartley Grattan here continues his emphasis on "Education for Understanding": we should emphasize the world of the mind in helping older persons to consider the meaning of life.

The strength of this volume is in the variety of issues it raises. While no research methods are treated in any detail, several research leads are provided, especially in the categories of Linden and the comparative construct of Friedmann. Vision and concern are evident throughout. One could have wished for at least one report on research completed or in progress. The volume might have been improved with editorial transitions between the papers. However, as an introduction to the subject, the volume is indispensable.

MAX KAPLAN
School of Fine and Applied Arts
Boston University

## BOOKS RECEIVED

Advisory Board on Problems of Older Workers, Bureau of Employment Security. *Breaking Through the Age Barrier.* Department of Labor and Industry, Commonwealth of Pennsylvania, May, 1958. Pp. 30. (paper).

National Committee on the Aging. *Current Developments in Preparation for Retirement.* New York: National Social Welfare Assembly, Inc., 345 East 46th Street, May, 1958. Pp. 32. $.50. (paper).

New York State Joint Legislative Commitee on Problems of the Aging. *Good News for Later Life* (1958 Legislative Document No. 8). Pp. 169. (paper). Obtainable through State Senator Thomas C. Desmond, Chairman, New York State Joint Legislative Committee on Problems of the Aging, 94 Broadway, Newburgh, New York.

Welford, A. T. *Ageing and Human Skill.* New York: Oxford University Press for the Nuffield Foundation, 1958. Pp. vi + 300. $4.00.

JOURNAL OF GERONTOLOGY

VOLUME 13, NUMBER 4
OCTOBER, 1958

# Section C

## Organization Section
## Author Index to Current Periodical Literature
## Index to Volume 13

VOLUME 13, SECTION C OCTOBER, 1958 NUMBER 4

# ORGANIZATION SECTION

## *Program*

### Eleventh Annual Meeting of the Gerontological Society, Inc.

**November 6, 7, and 8, 1958**

**BELLEVUE STRATFORD HOTEL**

**Philadelphia, Pennsylvania**

***Program Chairmen***

W. Andrew

M. ROCKSTEIN, Biological Sciences

E. W. BUSSE, Clinical Medicine

J. T. Freeman

ETHEL SHANAS, Psychological and Social Sciences

W. M. BEATTIE, JR., Social Welfare

**General Theme: *Unity in Diversity***

*Thursday, November 6*

| | |
|---|---|
| 8:30–10:00 | Registration and Committee Meetings |
| 10:00–12:00 | Introductory Session |
| 12:00– 2:00 | Section Luncheons and Meetings |
| 2:00– 4:30 | Papers, Four Concurrent Sessions |
| 8:00–10:30 | Public Meeting |

*Friday, November 7*

| | |
|---|---|
| 9:00–11:30 | Symposium on Gerontology in Biology and Medicine |
| 2:00– 4:30 | Symposium on Gerontology in Social and Psychological Sciences and Social Welfare |
| 6:00– 7:30 | Reception |
| 7:30– 9:30 | Annual Banquet |

*Saturday, November 8*

| | |
|---|---|
| 9:00–11:30 | Papers, Four Concurrent Sessions |
| 11:30–12:30 | Business Meeting |

Participation of our distinguished foreign guests in this conference was supported in part by research grant, H-3939, from the National Heart Institute, Public Health Service. The visiting scientists are:

Doctor José Froimovich, Valparaiso, Chile
Doctor Manuel Payno, México, D.F., México
Doctor Joaquín Quinteró, Caracas, Venezuela
Doctor Satamu Watanabe, Tokyo, Japan

## THURSDAY, NOVEMBER 6, 1958

8:30–10:00 a. m.—Registration, Eighteenth Floor;
Committee Meetings.

10:00 a. m.–12:00 noon

### Introductory Session

### Retrospect and Prospect in Gerontology

Rose Garden Room

*Co-Chairmen:* W. ANDREW, Professor of Anatomy, Indiana University, Indianapolis, and J. T. FREEMAN, Clinical Assistant Professor of Medicine, Women's Medical College of Pennsylvania, Philadelphia.

SHOCK, N. W., Chief, Section on Gerontology, U. S. Public Health Service, Bethesda: Biological Sciences.

GUNDERSEN, G., President, American Medical Association, La Crosse, Wisconsin: Clinical Medicine.

HAVIGHURST, R. J., Professor of Education, University of Chicago: Psychological and Social Sciences.

RANDALL, OLLIE A., Consultant on Aging, Community Service Society, New York: Social Welfare.

PAYNO, M., President of the First Pan American Congress of Gerontology, México, D. F., México.

12:00 noon–2:00 p. m.

### Luncheon Meetings of the Four Sections

South Garden Room

2:00 p. m.–4:30 p. m.

### Papers, Four Concurrent Sessions

### Biological Sciences

South Garden Room

*Chairman:* M. ROCKSTEIN, Associate Professor of Physiology, New York University College of Medicine, New York.

2:00 p. m.

WEXLER, B. C., AND MILLER, B. F.: Accelerated Aging and Arteriosclerosis Induced in the Rat with ACTH.

2:15 p. m.

GERSHBERG, H., AND HULSE, MILDRED C.: Human Growth Hormone in Aging.

2:30 p. m.

TERADA, H.: Studies of Growth Throughout the Life Span in Japanese: Growth of Axillary Hair in a Random Population of Subjects and Supplementary Observations of Families and Twins.

2:45 p. m.

KOHN, R. R.: Relationship of Age to Swelling Properties of Human Myocardium.

3:00 p. m.

TONNA, E. A., AND PILLSBURY, N.: Effects of Aging on the Mitochondrial Complement of Periosteal Osteoblasts and the Possible Significance to Bone Growth, Development, and Repair.

3:15 p. m.

GREEN, H., AND SOLOMON, SHIRLEY A.: Hexokinase Activity of Rabbit Lens. Effect of Age.

3:30 p. m.

Intermission

3:35 p. m.

THUNG, P. J.: Comparative Gerontology of Mouse and Human Ovaries.

3:50 p. m.

SCHWARZ, H. P., DREISBACH, L., CHILDS, R., MASTRANGELO, S. V., AND KLESCHICK, A.: Preliminary Studies of Chromatographically Separated Lipids of the Brain in Aging.

4:05 p. m.

STREICHER, E.: Effect of a Low Calcium Diet on the Calcium Content of Rat Brain.

4:20 p. m.

CLAY, M. M., AND KAUFMAN, L.: Effect of Chronic Stress upon Systolic Blood Pressure of Albino Rats.

4:30 p. m.

ROGERS, J. B., JOHNSON, W. L., AND ROGERS, J. H.: Effect of Aging on the Growth of the Incisor Teeth of the Guinea Pig.

4:40 p. m.

SMITH, J. G., JR., BRUNOT, F., AND BLANK, H.: Studies on Sebaceous Gland Function in the Aged.

4:50 p. m.

GARBUS, J., AND WEINBACH, E.: Age and Nucleotide Levels in Rat Liver and Brain.

### Clinical Medicine

Reception Room

*Chairman:* E. W. BUSSE, Director, Center for the Study of Aging, Duke University, Durham.

*Moderator:* G. H. HUNT, Director, Center for Research on Aging, National Institutes of Health, Bethesda.

2:00 p. m.

BERKOWITZ, D., LIKOFF, W., AND SKLAROFF, D. M.: Radioactive Fat Absorptive Patterns in Older Patients.

*Discussant:*

P. T. KUO, Assistant Professor of Medicine, University of Pennsylvania School of Medicine, Philadelphia.

2:20 p. m.

HARRIS, R., AND ARAVANIS, C.: Some Cardiac Parameters of Senescence.

*Discussant:*

J. J. MOYER, Professor of Medicine, Hahnemann Medical College, Philadelphia.

2:40 p. m.

KAHN, R. L., POLLACK, M., GERBER, I., AND GOLDFARB, A. I.: Relationship of Physical to Mental Status in Institutionalized Aged Persons.

*Discussant:*

R. H. DOVENMUEHLE, Research Coordinator, Center for the Study of Aging, Duke University, Durham.

3:00 p. m.

ROBERTS, B.: Vascular Replacement in Surgery.

*Discussant:*
W. ANLYAN, Associate Professor of Surgery, Duke University, Durham.

3:20 p. m.

BOGDONOFF, M. D., ESTES, E. H., JR., COMBS, J. J., JR., BRYANT, G. D., and WARREN, J. V.: Effects of Acute Psychic Stress on Blood Lipids.

*Discussant:*
E. D. WEISS, Professor of Clinical Medicine, Temple University, Philadelphia.

3:40 p. m.

BOUCOT, KATHARINE: Survival in Lung Cancer.

*Discussant:*
G. ROSEMOND, Professor of Clinical Surgery, Temple University, Philadelphia.

4:00 p. m.

WINNIMAN, MYRNA, AND GERTMAN, S.: Nutritional Status of a Group of Geriatric Clinic Patients.

*Discussant:*
W. B. KOUNTZ, Assistant Professor of Clinical Medicine, Washington University School of Medicine, St. Louis.

## Psychological and Social Sciences

North Garden Room

*Chairman:* E. A. FRIEDMANN, Department of Sociology, University of Wisconsin, Madison.

2:00 p. m.

BOONE, D. R.: Variations in Communication Skills Among Hemiplegics.

2:15 p. m.

RIKLAN, M., DILLER, L., AND WEINER, H.: Psychosocial Studies in Geriatric Parkinsonism.

2:30 p. m.

BIRREN, J. E., BOTWINICK, J., WEISS, A. D., AND MORRISON, D. F.: An Analysis of Perceptual and Mental Tests Given to Healthy Elderly Men.

2:45 p. m.

SHMAVONIAN, B. M., SILVERMAN, A. J., AND COHEN, S. I.: Assessment of Central Nervous System Arousal in the Elderly.

3:00 p. m.

BLANK, P.: Preparation for and Participation of Volunteers in an Aged Study.

3:15 p. m.

Intermission

3:30 p. m.

GOLDSTEIN, S.: Consumer Patterns of Aged Spending Units.

3:45 p. m.

WENTWORTH, EDNA C.: A Longitudinal Study of the Retirement Situation of Aged Beneficiaries of Old Age and Survivor's Insurance.

4:00 p. m.

NEUGARTEN, BERNICE, AND OLSEN, K. M.: Generational and Status Differences in the Patterning of Life Events: A Study of Middle-Aged Men.

4:15 p. m.

THOMPSON, W. E., AND STREIB, G. F.: Reminiscences of Retirees: The Effect of the Retirement Experience.

## Social Welfare

Rose Garden Room

*Chairman:* L. R. CANTOR, Executive Director, Beth Sholom Home of Virginia, Richmond.

2:00 p. m.

LENZER, A.: Local Committees on Aging in Michigan.

2:30 p. m.

CHAFIN, LILLY H.: The Social Worker as a Participant in Medical Care and Research on the Aged.

3:00 p. m.

UNDERWOOD, B.: Emerging Definitions and Classifications of Nursing Homes and Their Services.

3:30 p. m.

LINDEN, M. E.: Trends in Care of the Non-Psychotic Aged in an Institutional Setting.

4:00 p. m.

MORRIS, R.: The Future of Institutional Programs for the Aging.

8:00–10:30 p. m.

## Public Meeting
## Gerontology and the National Scene

Rose Garden Room

*Introduction:* F. P. CORSON, Methodist Bishop, Philadelphia.

*Speaker:* BERTHA S. ADKINS, Under Secretary of the Department of Health, Education, and Welfare.

# FRIDAY, NOVEMBER 7, 1958

9:00 a. m.–11:30 a. m.

## Symposium on Gerontology in Biology and Medicine

Rose Garden Room

*Chairmen:* E. W. BUSSE, Director, Center for the Study of Aging, Duke University, Durham, North Carolina.

M. ROCKSTEIN, Associate Professor of Physiology, New York University College of Medicine, New York.

CASARETT, G. W., Department of Radiation Biology, University of Rochester School of Medicine and Dentistry. Cellular Effects of Radiation and the Aging Process.

HRACHOVEC, J., AND ROCKSTEIN, M., Department of Physiology, New York University College of Medicine. Age Changes in Lipid Metabolism in Mammals and Their Medical Implications.

BEARD, BELLE B., Chairman, Department of Sociology, Sweet Briar College. The Relation of Sociological Studies to Biological Aspects of Aging.

WATANABE, S., Chief Director, Gerontological Society of Japan. Some Aspects of Gerontology in Japan.

FROIMOVICH, J., Laboratory of Experimental Medicine, Valparaiso, Chile. Humoral Biochemistry at Different Ages in Chile.

2:00 p. m.–4:30 p. m.

**Symposium on Gerontology in Social and Psychological Sciences and Social Welfare**

Rose Garden Room

Patterns of Successful Aging

*Chairman:* W. C. FITCH, Director, Special Staff on Aging, Department of Health, Education, and Welfare, Washington, D. C.

HENRY, W. E., Chairman, Committee on Human Development, University of Chicago: Patterns of Aging.

BUSSE, E. W., AND DOVENMUEHLE, R. H., Center for the Study of Aging, Duke University, Durham. Patterns of Successful Aging.

CUMMING, ELAINE, Kansas City Study of Adult Life, Kansas City, Missouri. Some Aspects of Successful Aging.

KAPLAN, J.: Executive Director, Mansfield Memorial Homes, Inc., Mansfield, Ohio. Successful Aging Through Social Work.

*Commentators:*

MARGARET BLENKNER, Director, Study Project in Services for the Aging, Community Service Society, New York.

R. MONROE, Clinician, Boston.

6:00 p. m.–9:30 p. m.

**Presidential Evening**

6:00 p. m.

**Reception and Social Hour**

South Garden Room

7:30 p. m.–9:30 p. m.

**Banquet**

Rose Garden Room

Gerontological Essay Award. Sponsored by Gerontological Research Foundation

Recognition of Honored Guests

Comments by J. QUINTERO Q., Director, Patronato Nacional de Ancianos de Venezuela, Caracas, Venezuela.

Presidential Address: A. I. LANSING, Professor of Anatomy, University of Pittsburgh School of Medicine.

## SATURDAY, NOVEMBER 8, 1958

9:00 a. m.–11:30 a. m.

**Papers, Four Concurrent Sessions**

### Biological Sciences

South Garden Room

*Chairman:* W. ANDREW, Professor of Anatomy, Indiana University School of Medicine, Indianapolis.

9:00 a. m.

HORRINGTON, EMILY, POPE, F., LUNDSFORD, WANDA, AND MCCAY, C. M.: Parabiosis Between Rats of Different Sizes and Ages.

9:15 a. m.

LESSER, G., PERL, W., AND STEELE, J. M.: Composition of the Body in Aging.

9:30 a. m.

YIENGST, M. J., ANDREW, W., BARROWS, C. H., JR., AND SHOCK, N. W.: Correlation of Biochemical and Histological Changes with Age in a Tissue Composed of Reversible Postmitotic Units (Liver) and in One Composed of Irreversible Postmitotic Units (Skeletal Muscle).

9:45 a. m.

BERG, B. N.: Food Intake, Growth, and Obesity in Relation to Longevity, Disease, and Fertility in the Rat.

10:00 a. m.

ROSS, M. H., AND BATT, W. G.: Aging in the Rat: Hepatic Enzyme Activity and Population Variation.

10:15 a. m.

Intermission

10:25 a. m.

FALZONE, J. A., JR., BARROWS, C. H., JR., AND SHOCK, N. W.: Effect of Age on Polyploidy in Rat Liver.

10:40 a. m.

BYRD, E.: Taste Sensitivity in Aging.

10:55 a. m.

NORRIS, A. H., SHOCK, N. W., AND LANDOWNE, M.: Age Differences in Height and Weight of Men.

11:10 a. m.

SASAKI, J. D.: Application of the Law of Conservation of Energy (LCE) with $E = MC^2$ to Human Life and the Use of Accommodative and Convergence Function as a Guide in the Prevention of Biological Aging.

### Clinical Medicine

Reception Room

*Chairman:* E. W. BUSSE, Director, Center for the Study of Aging, Duke University, Durham.

*Moderator:* I. H. SCHEINBERG, Professor of Medicine, Albert Einstein College of Medicine, Yeshiva University, New York.

9:00 a. m.

GERTMAN, S.: Meeting Basic Needs—a New Method of Approaching Geriatric Clinic Patients.

*Discussant:*

M. E. LINDEN, Director, Division of Mental Health, Department of Public Health, Philadelphia.

9:20 a. m.

COHEN, T., AND GITMAN, L.: Taste Perception in the Aged.

*Discussant:*

J. BOTWINICK, Section on Aging, National Institute of Mental Health, Bethesda.

9:40 a. m.

OBRIST, W. D., PERLIN, S., AND SOKOLOFF, L.: Relation of EEG to Cerebral Metabolism and Organic Mental Signs in Healthy Old People.

*Discussant:*

E. W. BUSSE, Professor and Chairman, Department of Psychiatry, Duke University, Durham.

10:00 a. m.

GELFAND, M. L.: Cardiac Arrhythmias in the Elderly—An Early Manifestation of Heart Failure.

*Discussant:*

S. BELLET, Professor of Clinical Cardiology, University of Pennsylvania Graduate School of Medicine, and Professor of Medicine, Women's Medical College, Philadelphia.

10:20 a. m.

NICHOLS, C. R., AND OBRIST, W. D.: Relation of Serum Cholesterol Level to Age, Race, and Sex in a Community Group of Elderly People.

*Discussant:*

E. STREICHER, Research Biochemist, Section on Aging, National Institute of Mental Health, Bethesda.

10:40 a. m.

STRASSMANN, G.: Aortic Thrombosis and Aneurysms in Mentally Sick Patients Over Sixty.

*Discussant:*

M. D. BOGDONOFF, Assistant Professor of Medicine, Duke University, Durham.

11:00 a. m.

SILVERMAN, A. J., COHEN, S. I., AND SHMAVONIAN, B. M.: Psychophysiological Response Specificity in the Elderly.

*Discussant:*

A. D. WEISS, Research Psychophysiologist, Section on Aging, National Institute of Mental Health, Bethesda.

## Psychological and Social Sciences

North Garden Room

*Chairman:* J. E. Birren, Chief, Section on Aging, National Institute of Mental Health, Bethesda.

9:00 a. m.

GOLDE, PEGGY, AND KOGAN, N.: A Test of the Generality of Beliefs and Attitudes Regarding Old People.

9:15 a. m.

POLLACK, M., KAHN, R. L., AND GOLDFARB, A. I.: Disorientation Patterns in Institutionalized Aged Persons.

9:30 a. m.

BROWN, R. G., AND JEFFERS, FRANCES C.: Regional Variation in the Pattern of Isolation of Older Persons.

9:45 a. m.

ORBACH, H. L.: Age and Religious Participation in a Large Metropolitan Area.

10:00 a. m.

Intermission

10:15 a. m.

POLNER, W.: New Group Plans to Provide Voluntary Health Insurance for the Retired: Survey of Their Characteristics.

10:30 a. m.

DONAHUE, W.: Training in Social Gerontology.

10:45 a. m.

BREEN, L. Z., AND SPAETH, J. L.: Age and Productivity.

11:00 a. m.

FRIEDMANN, E. A., AND STEWART, W.: Participation in Adult Education Programs for College Graduates in the Middle Years.

11:15 a. m.

BRITTON, J. H., AND MATHER, W. G.: Factors in Criterion Measures of Adjustment of Older Adults.

## Social Welfare

Rose Garden Room

The Pros and Cons of Gerontological Training for Those Providing Social Welfare Services for the Aging.

*Chairman:* L. KUPLAN, Executive Secretary, Citizens' Advisory Committee on Aging, State of California, Sacramento.

9:00 a. m.

WHITE, GRACE, Consultant on Educational Services, Council on Social Work Education, New York. The Contribution of Social Work Education to the Preparation of Personnel for Service to the Aging.

9:30 a. m.

SUMNER, DOROTHY, Associate Professor, New York School of Social Work. Social Work Education: Knowledge for Use in Working with the Aged.

10:00 a. m.

EMERY, MARIAN, Administrative Assistant, Family Service Bureau, United Charities of Chicago. The Pros and Cons of Gerontological Training as Viewed by a Social Work Practitioner.

10:30 a. m.

Discussion

11:30 a. m.–12:30 p. m.

BUSINESS MEETING OF GERONTOLOGICAL SOCIETY, INC.
Rose Garden Room

# Abstracts

*All abstracts are edited by the respective Section Program Chairmen.*

## SECTION ON BIOLOGICAL SCIENCES

*Abstracts edited by Morris Rockstein, Ph.D.*

**Food Intake, Growth, and Obesity in Relation to Longevity, Disease, and Fertility in the Rat.**

BENJAMIN N. BERG, *Department of Pathology, College of Physicians and Surgeons, Columbia University, New York.*

Rats fed ad libitum and reaching maximum size were compared with smaller animals on controlled food consumption, in relation to disease susceptibility, longevity, and female fertility.

In a group of rats on a restricted diet, food intake starting at weaning was reduced by 35% from the amount consumed by animals fed ad libitum. Body weight was 25 to 30% lower in diet-restricted rats and tibia length was 5% shorter. Body size at 800 days corresponded roughly to measurements of 150-day-old unrestricted animals. Growth and weight curves of restricted rats were similar to those of unrestricted ones except at a lower level. Obesity developed in animals fed ad libitum but not in rats with a limited food intake.

The experiment was terminated at 800 days and all survivors were killed. Male mortality was reduced from 50% in unrestricted rats to 12% in restricted ones; female mortality was 6% in both groups. Principal causes of death were chronic glomerulonephritis and periarteritis of the mesenteric vessels. Lesions were present in all unrestricted males; in females fed ad libitum renal disease existed in 50% and vascular changes in 25% of 800-day-old survivors. Myocardial degeneration was a contributory finding, more prevalent in males than in females. Restricted rats of both sexes were practically free from cardiovascular renal disease.

Sixty % of restricted females 700 days to 800 days old bore litters, while 10% of 600-day to 700-day-old females on unlimited food intake were fertile.

Dietary control prevented obesity and maintained good growth, vigor and nutrition. Restricted rats were less susceptible to disease and had greater longevity and fertility than obese animals attaining maximum size.

An important feature of this work was the absence of lung infection in our animals, a disease that is endemic in most colonies and interferes seriously with satisfactory long-term rat studies.

---

**Taste Sensitivity in Aging.**

EUGENE BYRD, *Institute of Gerontology, University of Miami School of Medicine.*

It has been established that the number of taste buds decreases markedly with age. This study explores the functional sensitivity of the 4 basic taste qualities at various age levels. Solutions, concentrations, and technique for testing taste as suggested by Börnstein were used on 3 groups of persons at 3 age levels between 20 and 90 years. Differences between groups were statistically analyzed for each taste quality and for each side of the tongue. Taste perception does not follow the pattern of marked anatomical change in numerical and topographical relations of taste buds.

---

**Effect of Chronic Stress Upon Systolic Blood Pressure of Albino Rats.**

MICHAEL M. CLAY AND LEONARD KAUFMAN, *Columbia University College of Pharmacy, New York.*

The following is the first of a series of studies which will be concerned with the effects of chronic environmental or behavioral stress upon the circulatory and related systems. Male albino Wistar strain rats were divided into 3 experimental and 1 control groups. Group 1 was maintained at 8 C.± 2 continuously for 56 days followed by 33 days during which the rats were forced to swim for 1½ hours per day, 6 days per week. Group 2 was maintained for about 1½ hours per day, 6 days per week at 10 C.± 2 for 56 days followed by 33 days of continuous maintenance at 8 C.± 2. Group 3 was forced to swim 1½ hours per day, 6 days per week for 42 days followed by 33 days of continuous audiogenic stimulation. Group 4 was maintained at 22 C.± 2 throughout as a control group. Systolic blood pressures were estimated with the photoelectric tensiometer by the method of Kersten at least once weekly throughout the courses of treatment. Kidneys, heart, adrenal glands, and spleen were removed and weighed after completion of treatment. After 56 days of treatment the mean systolic blood pressure of Group 1, 2, and 4 were 158, 134, and 125 mm. Hg, respectively. After 42 days of treatment the mean systolic blood pressures of Group 3 and 4 were 154 and 129 mm. Hg, respectively. Mean systolic blood pressures of Groups 1 and 2 had been stable for at least 3 weeks after 56 days of treatment. Mean systolic blood pressure of Group 3 was stable for 3 weeks after 42 days of treatment.

---

**Effect of Age on Polyploidy in Rat Liver.**

JOSEPH A. FALZONE, JR., CHARLES H. BARROWS, JR., AND NATHAN W. SHOCK, *Gerontology Branch, National Heart Institute, National Institutes of Health, P.H.S., D.H.E.&W., Bethesda, and the Baltimore City Hospitals.*

Many organisms exhibit the phenomenon of polyploidy, or extra chromosome sets, within the nuclei of some or all of their tissues. In several mammalian species, polyploidy of hepatic nuclei is the usual condition, as evidenced by increased chromosome number, DNA content, and nuclear volume. Size measurements of hepatic nuclei in the mouse suggest that this polyploidy may increase with age. To investigate this, we determined chemically the mean DNA content per nucleus in a total of 38 rats of both sexes and two age

groups, 12 and 24 months. No significant age or sex differences were found.

However, as nuclei from the stromal elements of liver contribute significantly to these mean values and are *not* polyploid (as shown by DNA analyses of separated stromal fractions) it is evident that any age changes in the relative proportions of stromal and hepatic nuclei could mask increased polyploidy of hepatic nuclei by simple dilution. This factor was ruled out by differential counts (stromal vs. hepatic) performed on all nuclear suspensions and by volume measurements on hepatic nuclei *alone*, neither of which estimates showed any significant age or sex differences. The practical significance of these negative findings is that DNA concentration may serve as a measure of nuclear concentration and may be used as such in age comparisons of rat liver biochemistry.

**Age and Nucleotide Levels in Rat Liver and Brain.**

JOEL GARBUS AND EUGENE WEINBACH, *Laboratory of Tropical Diseases, National Institute of Allergy and Infectious Diseases and Section on Aging, Laboratory of Psychology, National Institute of Mental Health, Public Health Service, U. S. Department of Health, Education, and Welfare, Bethesda.*

Previous studies have shown that the level of oxidation and concomitant phosphorylation are lower in liver preparations from aged rats. Studies are now in progress to elucidate the site of this deficit. As the pyridine-nucleotides are known to play an important role in cellular metabolism and especially in oxidative phosphorylation, nucleotide levels have been measured in whole liver and brain tissue, as well as mitochondria obtained from old and young rats. The results of independent methods of analysis indicate that nucleotide levels are lower in the tissues of the older animals.

**Human Growth Hormone in Aging.***

HERBERT GERSHBERG, AND MILDRED C. HULSE, *Departments of Medicine and Physiology, New York University College of Medicine, and Bellevue Hospital, New York.*

We have shown that the pituitaries of human adults ranging from 38 to 72 years of age contain as much growth hormone as the pituitary of a fetus or a growing boy. Since the pituitary content may not reflect the amount secreted to the blood, and since assays of growth hormone in blood are unsatisfactory, experiments were designed to measure the secretion of the hormone from the pituitaries of animals of different ages. The assay used was the increase in cardiac glycogen of rats after an overnight fast. It was found that immature and mature rats attained the same level of cardiac glycogen. These experiments strongly suggest that mature animals and man secrete as much growth hormone as the immature species.

Because previous experiments with growth hormone in man have been unsatisfactory due to the ineffectiveness of animal preparations, a purified human growth hormone was prepared and injected into adult humans. The following prompt metabolic changes resulted: decrease in blood urea and urea excretion, increase in blood glucose and inorganic phosphate, and increase in urea and creatinine clearance.

From these observations certain inferences may be made: 1) that growth hormone is an important regulator of metabolism in adult man and 2) that cessation of growth in man is associated with a diminished responsiveness of the peripheral tissues to growth and not to a lack of the growth hormone.

* This research was supported in part by a grant from the U. S. Public Health Service.

**Hexokinase Activity of Rabbit Lens. Effect of Age.**

HARRY GREEN AND SHIRLEY A. SOLOMON, *(with technical assistance of Caroline A. Hamblin), Wills Eye Hospital, Philadelphia.*

Homogenates of lenses prepared from 3-4 week and 3-year-old rabbits were used to study the effect of age upon the hexokinase activity in the crystalline lens. With both age groups, under optimal conditions of pH and concentration of glucose, the enzymatic activity, as indicated by the rate of disappearance of glucose, was linear with time, at least up to 30 minutes, under the given experimental conditions. Characterization of the enzymes from the two age-different lenses, e.g., pH optimum, optimal substrate concentration, Michaelis-Menten Constant indicate that with age the biochemical characteristics of the hexokinase are unaffected. Furthermore, while the total enzyme activity of the lens did not change appreciably with age, the concentration in the older lens was markedly lower than in the younger lens. The distributions of hexokinase between the nucleus, cortex and capsule-epithelium was also studied. The results will be discussed in terms of the growth characteristics of the lens.

**Parabiosis Between Rats of Different Sizes and Ages.**

EMILY HORRINGTON, FRANK POPE, WANDA LUNSFORD, AND CLIVE M. MCCAY, *Cornell University, Ithaca.*

Combinations have been made between rats differing in both size and age. These rats are now in middle life and show no signs of premature senescence. Blood pressure measurements have been made upon a substantial number of parabiotic rats in which the members of pairs differ in age. Special study has been devoted to the bones of these animals to determine if deterioration of the bones is retarded in the older animals.

**Relationship of Age to Swelling Properties of Human Myocardium.**

R. R. KOHN, *Institute of Pathology, Western Reserve University, Cleveland.*

The frequent occurrence of congestive heart failure, in the absence of specific cardiac pathology, and the low turnover rate of cardiac proteins suggest that deleterious molecular changes might occur in human myocardium with advancing age. To detect changes with age in protein structure, swelling properties of human myocardium in solution of NaOH and HCl were investigated. Fragments of approximately 150 hearts were incubated in solutions of various pH values and increases in weight were used as measures of swelling ability. Swelling peaks occurred at pH 0.9,, 2.4 and 11.2. Swelling was maximal at pH 11.2 and subsequent studies were carried out at this pH level. There is a rapid decrease in swelling ability during the first three years of life. Extent of swelling then remains constant until another decrease occurs between the ages of 30 and 50 after which swelling ability remains at a low level. Collagen content, percentage of

solid material, and amount of solids extracted during swelling do not vary significantly with age. Heating myocardium at 56 C. causes a rapid decrease in swelling ability. The possible role of thermal denaturation in aging and possible physiological implications of decreased swelling ability are discussed.

**Composition of the Body in Aging.**

GERSON LESSER, WILLIAM PERL, AND J. MURRAY STEELE, *New York University Medical Division, New York.*

The composition of the fat-free portion of the mammalian body, the so-called lean body mass, is approximately constant throughout much of the adult life as far as the proportion of water proteins and minerals is concerned (73% water, 27% proteins and minerals). Effects of the aging process on the amount and relative composition of the lean body mass are largely unknown. The aim of these studies is to determine the ratio of body water to lean body mass as a function of age. Determination of this ratio requires simultaneous measurement of total body water and total body fat. Total body fat subtracted from total body weight yields a figure for lean body mass. A measure of body fat is essential to a study of the proportion of water in the lean body mass because of the extreme variability in fat content of an individual.

Total body fat has been determined on living rats by measurement of the absorption of the inert, highly fat-soluble gas cyclopropane from a closed respiratory system (Lesser and associates, 1952). Application to humans has been more difficult because of the longer time necessary for the human subject to come into equilibrium with the external gas concentration. Theoretical analysis of the gas absorption curves has become necessary to predict equilibrium gas absorption values. Accurate curve fitting by exponential functions is being used. Preliminary results indicate that an accuracy of $\pm$ 15% in determination of body fat content of humans can be attained.

The methods of theoretical analysis leading to the prediction of equilibrium values for body fat will be briefly presented.

**Age Differences in Height and Weight of Men.**

ARTHUR H. NORRIS, NATHAN W. SHOCK, AND MILTON LANDOWNE, *Gerontology Branch, National Heart Institute, National Institutes of Health, P.H.S., D.H.E. &W., Bethesda, and the Baltimore City Hospitals.*

During a 10-year period, 840 men, who served as subjects for physiological tests in this laboratory, were measured and weighed without shoes while wearing ordinary clothing. As the age of the subjects increased from 20 to 89 years, the average decrements in height and weight were found to be 0.18 cm. per year and 0.16 Kg. per year, respectively. The tallest subjects, 20-29 years old, were similar in height (176 cm.) to 20-29 year old subjects in recent samples of the populations of Bergen, Norway, and Baltimore, Maryland (chronic disease survey), and were about 3 cm. taller than the average Canadian man of similar age. The average decrement in height of the above groups was about 2 cm. per age decade. Swedish and American men have shown a secular increase in height of about 1 cm. in 10 years. Thus, reduction of 1 cm. in height per age decade remains and may be attributed to anatomical changes associated with aging or to earlier mortality of tall people. Decrease in mean weight with age may reflect more sensible nutrition of Baltimoreans sampled, and Canadians in general, and can hardly be ascribed to earlier mortality of heavy subjects alone, since this effect is subordinated in Norwegian and English males whose weight increased until age 60-70. Longitudinal studies are needed for describing age changes.

**Effect of Aging on the Growth of the Incisor Teeth of the Guinea Pig.***

JAMES B. ROGERS, WALTER L. JOHNSON, AND JOHN H. ROGERS, *University of Louisville School of Dentistry.*

The purpose of our research was to determine the growth rate of the incisor teeth and the variation of the growth rate in the different age groups of the guinea pig.

The investigation included a total of 140 guinea pigs, using both postmortem and living animals of the following age groups: young, 0-365 days; mature, 366-730 days; old, 731-1,095 days; senile, 1,096 days and older.

Ten postmortem specimens of each age group were used to denote the difference in the length of the incisor teeth in the different ages. Twenty-five living guinea pigs of each group, kept under relatively constant dietary and environmental conditions, were used for observing the continuous growth of the incisor teeth and the changes in growth rate in the different age groups.

The length of the incisor teeth for different ages of the postmortem specimens was about the same. Measurements of the incisor teeth of the living guinea pigs revealed that the growth rate remains constant throughout life with no discernible difference in the various age groups. The rapid growth of 1.56 mm. for the upper incisors, and 2.01 mm. for the lower incisors, per week is necessary to compensate for attrition, thus keeping the teeth at a constant level during life of the animal. Since the average of the clinical crown of the adult guinea pig is about 8 mm. the crown is renewed by new dental tissue about every 4 weeks.

* This study was supported by Research Grant H2638 from the National Heart Institute and by Dental Student Research Scholarship FD142, National Institutes of Health; Department of Health, Education and Welfare.

**Aging in the Rat: Hepatic Enzyme Activity and Population Variation.**

MORRIS H. ROSS AND WILLIAM G. BATT, *Biochemical Research Foundation, Newark, Delaware.*

The hypothesis that the aging processes are correlated with enzyme activity levels and patterns is now under study and is being tested by determining if an alteration of these patterns by dietary means affects the aging processes. This study, now nearing completion, was begun with more than 1000 male rats all of identical chronological age (21 days). Activity determinations of hepatic catalase, adenosinetriphosphatase, histidase, and alkaline phosphatase were made at intervals ranging from 21 to 1000 days. Related factors also studied were: nitrogen, lipid and moisture content of liver, organ-body proportions, growth characteristics, weight and time relationships, disease states, mortality rate, incidence and type of gross pathological lesions, food intake, etc.

The activity of each enzyme was found to change with age, but at a certain chronological age a reversal in direction of all enzyme activity levels occurred. This change in direction took place at the same time and to the same degree within each dietary group. The time of transition in activity differed according to the dietary group and seemed to correlate directly with the average life span of each group. Coincident with the specific age when enzyme reversal pattern was noted was an increase in the degree of distribution of values, not only as to the enzyme activity values, but for all other assays. Subsequently, there was a direct relationship between the age of the rat and the increase in variation. The discussion will include the relationship among reversal in enzyme patterns, increasing variation, mortality rate, and tumor incidence.

**Application of the Law of Conservation of Energy (LCE) with $E=MC^2$ to Human Life and the Use of Accommodative and Convergence Function as a Guide in the Prevention of Biological Aging.**

JOSEPH D. SASAKI, *Clinician, Ann Arbor.*

The equation is formulated from the law of conservation of energy (LCE) with the use of equation, $E = MC^2$, where such a speed of life moves along the parabolic curve toward the positive direction ending with an equation when life becomes nonexistent due to exhaustion of the essential energy in storage within the body and to insufficient assimilable energy from without essential to the body while the body is under constant motion. Such an equation would help to understand life and longevity. Final basic equation is $L^2 = PE - KE + AE$.

Since the sympatho-adrenal discharge in the early stage of life is latent due to constant maintenance of body normalcy, homeostasis, the only manifestable measurement would be decreasing accommodative amplitude where such a curvature assumes a parabolic curvature, especially based on Donders' work. Such a decreasing accommodative amplitude, including an increasing convergence insufficiency, as age increases would be a manifestation of the hypoxic state of the body leading to increased amplitude of the sympatho-adrenal discharge to further continue to maintain body normalcy where in time the amount of energy in storage decreases with actual manifestations of sympatheticotonia later. Thus, the accommodative amplitude curve and the graphical interpretation of the convergence function are employed as a guide to the prevention of the biological aging of the human body.

Various charts and graphical pictures of convergence function are shown to explain this concept.

**Preliminary Studies of Chromatographically Separated Lipids of the Brain in Aging.***

H. P. SCHWARZ, L. DREISBACH, R. CHILDS, S. V. MASTRANGELO, AND A. KLESCHICK, *Division of Biochemistry, Philadelphia General Hospital.*

Studies of essential lipids (cholesterol, cholesterol esters, phospholipids, and cerebrosides) of the brain (human postmortem material) carried out in this laboratory and elsewhere did not show any changes in advanced age except for slight increase of cerebrosides in grey or white matter. In order to elucidate this problem further, sphingolipids of grey or white matter of the brain were separated by chromatography on silicic acid columns and the 30 fractions obtained from each fractionation were analyzed by infrared microspectrometry and chemical procedures. This study led to the isolation and partial characterization of 7 rather pure sphingolipids: Compound 1, a typical cerebroside probably phrenosin, Compound 2, a dehydro-cerebroside, Compound 3, ganglioside, Compound 4, sphingomyelin, Compound 5, a dehydro-phosphosphingoside with less phosphorus, Compound 6, a phosphosphingoside without infrared amide 2 band, and Compound 7, a dehydro-phosphosphingoside with characteristic infrared spectrum possibly indicating the presence of a cyclic lactam. The exclusive occurrence of the dehydrosphingoside with less phosphorus in grey matter of a case of dementia senilis is pointed out. It is concluded that analysis of finer structural changes of lipids of the brain may contribute to the elucidation of the possible role of lipids in aging.

* This work was supported by U. S. Public Health Grant B-976 of the National Institute of Nervous Diseases and Blindness.

**Studies on Sebaceous Gland Function in the Aged.**

J. GRAHAM SMITH, JR., FELIX BRUNOT, AND HARVEY BLANK, *Division of Dermatology, Department of Medicine, University of Miami School of Medicine.*

Sebaceous gland function of 10 young persons aged 15 to 18 years was compared with 9 others aged 70-87. Whatman No. 42 filter papers were replaced on the ether defatted skin of the foreheads of the subjects at intervals of 5 minutes over a period of 30-40 minutes and colored black by exposure for 2 minutes to the fumes of osmic acid. After complete darkening of the sebum on the papers had occurred, the degree of darkening was measured with a photoelectric densitometer. The young and old men had essentially the same levels of sebaceous gland activity. Lower levels of sebum delivery were found in the women as compared with the men; however, the levels were much lower in the aged women. Sex hormones were administered parentally to the aged individuals for 5 weeks. The men received testosterone enanthate in sesame oil and the women hydroxyprogesterone caproate in sesame oil. Sebum delivery was found to be increased in both groups, but the levels for the treated aged women did not equal that of the teen-age girls.

**Effect of a Low Calcium Diet on the Calcium Content of Rat Brain.**

EUGENE STREICHER, *Laboratory of Psychology, National Institute of Mental Health, National Institutes of Health, U. S. Department of Public Health, Education and Welfare, Bethesda.*

The fundamental relationship between age and the calcium content of animal tissues has been obscured by the large normal variations that are observed in the concentration of this element. Previous studies from this laboratory have demonstrated the existence of large bilateral differences in the calcium content of rat brain as well as an altered bilateral pattern of calcium distribution in old animals. Apparently much of this variability in distribution resulted from nonparenchymal deposition of the mineral. In current studies, rats are being maintained on a low calcium diet in an attempt to eliminate extracellular calcium deposits. The effect of this treatment on the brain calcium content of old and young rats will be presented.

**Studies of Growth Throughout the Lifespan in Japanese: Growth of Axillary Hair in a Random Population of Subjects and Supplementary Observations of Families and Twins.**

HARUMI TERADA, *Departments of Anatomy, Faculty of Medicine, University of Tokyo, and State University of New York, Brooklyn.*

Subjects consisted of a random population of 365 males and 335 females, 1 to 88 years of age; several families including 4 large ones with living parents; and 4 pairs of identical twins. Studies of hairs in the right axilla included (a) weight of the full-grown mass of hairs, (b) weight of hair grown per 24 hours, (c) total number of hairs, (d) mean length and (e) mean breadth of 3 longest hairs, (f) percentage of gray hairs.

In either sex, peak values for items (a), (b), and (c) were observed in the third decade, for items (d) and (e) in the third or fourth decades.

At all ages with the exception of early puberty, mean values tended to be higher in males than in females for items (a) through (e).

Studies of families and twins indicated that values for axillary hair, as compared with those for the beard, were subject to greater fluctuation from time to time in the same person and to greater decline with advancing age. These findings suggest that values for axillary hair conform to a greater extent than those for the beard to the waxing and waning of gonadal secretions.

---

**Comparative Gerontology of Mouse and Human Ovaries.**

P. J. THUNG, *Antoni van Leeuwenhoekhuis, Netherlands Cancer Institute, Gerontological Division, Amsterdam.*

Ovarian aging has been studied in mice and compared to that in humans. It was found that the differences between these species are related to the shorter life span, the higher rate of activity, and the different architecture of the mouse as compared to the human ovary. The former shows a much more rapid upbuilding and shifting of parenchymal elements and contains comparatively less connective tissue than the human ovary. Senile mouse ovaries correspondingly lack the fibrous and hyaline scars characteristic of the senile human ovary, while the proliferative tendencies of the aging germinal epithelium and ovarian rete tubules on the other hand are more striking in mice than in women. The occurrence, in senile mouse ovaries, of hypertrophic interstitial cells has its counterpart in stromal "hyperplasia" of aging human ovaries.

The hyperplastic and hypertrophic changes of aging ovaries are related to the involution of the follicular apparatus. Both roentgen irradiation and intrasplenic transplantation of mouse ovaries precipitate similar changes as are found, on a smaller scale, in normal ovarian aging. The proliferative activities of the aging germinal and rete epithelium may be viewed as an attempt to replace the waning follicular epithelium, this attempt being more successful in rodents than in women. The basic processes of ovarian involution, however, are similar in mice and women, if allowance is made for the differences in structural and temporal relations.

**Effects of Aging on the Mitochondrial Complement of Periosteal Osteoblasts and the Possible Significance to Bone Growth, Development, and Repair.**

E. A. TONNA AND N. PILLSBURY, *Department of Histo-Cytochemistry, Hospital for Special Surgery, New York.*

Previous work has shown that respiratory enzyme activity (cytochrome oxidase and succinic dehydrogenase) changed from birth to old age in the osteoblasts of the femoral periosteum of normal and traumatized rats. These changes paralleled alterations in osteoblastic morphology and the role of these cells in ossification. Respiratory enzyme activity was highest in young rats until the age of 5 weeks. This period was followed by successively lower levels with increasing age. Since respiratory enzymes are associated with mitochondria, it was the object of this investigation to study the following in normal rats from birth to old age, namely: 1) the changes in periosteal osteoblastic population, 2) alterations in the number and morphology of the mitochondrial complement of these cells, and 3) the possible biochemical relationship to the observed respiratory enzyme variations as related to bone growth and development.

The results indicated that active osteoblasts were present in large numbers in the femoral periosteum up to 8 weeks of age, falling sharply thereafter. Mitochondrial counts made of these cells revealed one-half the number that were present at 5 weeks of age. As the animal became older, the average mitochondrial number per osteoblast became less. The mitochondrial changes paralleled the variations in the respiratory enzyme activities. Moreover, the fall in the number of mitochondria and respiratory enzymes occurred prior to the fall in the number of periosteal osteoblasts.

These data support the previous findings that observed changes in bone growth and development are associated with changes in the osteoblastic activity and that the reduction in osteoblastic population and morphology follow changes noted in the mitochondrial complement of these cells and their associated respiratory enzymes.

---

**Accelerated Aging and Arteriosclerosis Induced in the Rat with ACTH.***

BERNARD C. WEXLER AND BENJAMIN F. MILLER, *May Institute for Medical Research of the Jewish Hospital and Medical Center, and the Departments of Pathology and Medicine, University of Cincinnati College of Medicine.*

Last year, a report was made to this Society of the production of severe arteriosclerosis in female rats and other degenerative lesions, such as periarteritis and premature senile fibrosis of the testis, in male rats. The animals were given ⅓ unit of ACTH (in gel), per 100 Gm., subcutaneously, 3 times weekly, for 7 weeks, and then sacrificed. These male and female rats (300-450 Gm.) had been used continuously as breeders. Unilateral nephrectomy, although not obligatory, was found to enhance the severity of the lesions. No salt or fat was added to the diet, i.e., standard rat chow was used.

Younger rats (100 Gm.) developed only microscopic types of coronary lesions in response to this treatment. Although the older female rats displayed severe arteriosclerosis, aortic aneurysms, and hypertension, their mor-

tality was low. They did not manifest the appearance of greatly accelerated aging. In contrast, the male rats, although showing no arteriosclerosis grossly, underwent unusually rapid deterioration, i.e., loss of appetite and weight, matted fur, sluggishness, and a high mortality rate. This rapid "aging" and death of the males could be definitely associated with injection of ACTH.

Pathological conditions of this kind have been reported in truly senile rats (3 years). In the present experiments, animals were 10-12 months of age. We suggest the possibility that in the rat, hyperadrenocorticalism may accelerate certain metabolic processes so as to cause premature wasting of tissue, initiate or enhance certain disease processes, and so lead to premature aging.

* This work was supported in part by the John A. Hartford Foundation.

**Correlation of Biochemical and Histological Changes with Age in a Tissue Composed of Reversible Postmitotic Units (Liver) and in One Composed of Irreversible Postmitotic Units (Skeletal Muscle).**

M. J. Yiengst, W. Andrew, C. H. Barrows, Jr., and N. W. Shock, *Gerontology Branch, U. S. Public Health Service, Baltimore City Hospitals, Baltimore, and Department of Anatomy, the Bowman Gray School of Medicine, Winston-Salem.*

A contrasting behavior of the ratio of extracellular water to the total water with increasing age in the rat has been shown for liver and skeletal muscle (Yiengst, Barrows, and Shock, 1956). No significant change was seen in liver, while the ratio was significantly increased in skeletal muscle, although the total water content was unaffected by age in both tissues. Intracellular components (N, K, and P) likewise showed no significant change with age in the liver but a significant decrease in skeletal muscle occurred.

Histological study and counts have been made of sections from the same livers which have been studied biochemically and from the muscles of the calf of the same rats from which the thigh muscles were used in the chemical study, in a random series of 12 of the 40 animals used in the original investigation and covering the same age range. An attempt has been made to see whether a correlation of biochemical and histological findings in the young and old rats as groups and as *individual* animals could be made.

The histological findings, both quantitative, and qualitative, do show what the biochemical data would indicate: namely, a loss of protoplasmic units (fibers) in the fixed postmitotic tissue (skeletal muscle) and a preservation of such units (cells) in the reversible postmitotic tissue (liver). The types of degeneration of the muscle fibers and the manner in which they are replaced by primarily non-cellular material such as connective tissue fibers and matrix are discussed. It is emphasized that histological and cytological age differences *are* seen in the liver, although these seem to involve practically no loss of cells. The biochemical and histological data are in agreement on a quantitative basis even in individual animals.

## SECTION ON CLINICAL MEDICINE

*Abstracts edited by E. W. Busse, M.D.*

**Radioactive Fat Absorptive Patterns in Older Patients.**

D. Berkowitz, W. Likoff, and D. M. Sklaroff, *Departments of Medicine and Radiology, Albert Einstein Medical Center, Northern Division, Philadelphia.*

Experience to date with radioactive fat studies has shown that this material may be used to assess fat absorption simply and accurately in many clinical conditions.

Thus, characteristic blood radioactivity curves after ingestion of a test meal of $I^{131}$ labeled triolein have been obtained in normal subjects, as well as in pancreatic disease, sprue, and obstructive jaundice. More recently we have described typical patterns in patients with coronary artery disease and hypercholesterolemia, alone or in combination (increased peak blood radioactivity levels) with a higher than normal value even after 24 hours.

Because of the paucity of information on fat absorption in the geriatric patient we have performed a radioactive fat tolerance test in 30 subjects whose age ranged from 65 to 85. Half of the group showed no evidences of any major disease state and served as controls. The remainder gave a history of a previous myocardial infarction.

In the coronary group, the fat absorption curves were similar to those that we have obtained in a group of younger patients with coronary disease.

In the "control" group, a majority showed a normal response. In some, however, a typical "coronary type" curve was obtained.

Our results thus far indicate that fat absorption in the older age patient follows in general the pattern seen in younger subjects. Elevated peak and 24-hour radioactivity levels that may be present in some after an oral radioactive fat tolerance test are indicative of an abnormality in lipid metabolism and presumably suggest that a significant degree of atherosclerosis is present even in the absence of clinical symptoms.

**Effect of Acute Psychic Stress on Blood Lipids.**

M. D. Bogdonoff, E. H. Estes, Jr., J. J. Combs, Jr., G. D. Bryant and J. V. Warren, *Center for the Study of Aging and Department of Medicine, Duke University, and Veterans Administration Hospital, Durham.*

The relationship of serum lipid level changes to the presence and development of atherosclerosis during aging has been an area of major investigation interest. Environmental stress has been found to be associated with rises in blood cholesterol. This has led to speculation regarding the significance of this effect, particularly its relation to coronary disease. Serum nonesterified fatty acids (NEFA) and triglycerides are much more labile lipid fractions than cholesterol, and it was believed that a study of the effect of more acute psychic stimuli on these fractions might prove interesting and informative.

Serum levels of NEFA and triglycerides were measured in 10 young male volunteers undergoing cardiovascular hemodynamic studies involving cardiac output and intravascular pressure measurements. Certain subjects received epinephrine injections, others electrical stimuli, others head-up tilt as an acute stress during the study. All subjects were aware of the general nature of the study, the necessity for a venous catheter, arterial and venous needles for measurements, etc., but were not aware of various acute stimuli to be added during the study. Similar levels were drawn in 5 subjects on another day as a control.

NEFA levels were higher and triglyceride levels were lower than on the control day. These effects were evident immediately after all needles and catheters were in place and before additional stimuli were received. There was a tendency for further changes during the study, but this was less striking than the initial effect.

The stress of a complex experimental study produced a rise in Serum NEFA and a fall in serum triglyceride levels. Anticipation of the study was apparently more effective in producing this effect than the additional acute stimuli introduced during the study.

---

**Survival in Lung Cancer.**

KATHARINE R. BOUCOT, *Women's Medical College of Pennsylvania, Philadelphia.*

Survival in lung cancer depends upon stage at time of detection, rate of growth, and invasive and metastasizing qualities. These important characteristics may be related to age, hormonal factors, tissue type, and site of tumor origin.

Among 250 consecutive cases of lung cancer from two official Philadelphia Survey Units, the best prognosis was for asymptomatic persons whose first film abnormalities were solitary pulmonary nodules.

The over-all 5-year survival rate from the time of the first abnormal chest x-ray was 17%. Unresected cases lived long periods of time—up to 9 years after the first abnormal film. Survival rates will be presented according to tissue type, age, and various other factors.

Because periodic chest x-rays are the only current method for early detection in asymptomatic men, it is recommended that chest x-ray films be taken semiannually in such men over 45.

---

**Taste Perception in the Aged.**

THEODORE COHEN AND LEO GITMAN, Brooklyn Hebrew Home and Hospital for the Aged.

As part of a program of clinical investigation of aged people, taste perception was studied in a group of residents in a geriatric facility.

In the course of daily contact with old people, one is impressed with the frequency of complaints relating to disturbance in taste. This stimulated a study of taste perception in 248 institutionalized individuals over age 65 years. The control group consisted of 100 younger adults. The ability to discern sweet, sour, salty, and bitter was determined in a standardized manner.

The results may be summarized as follows:

1) There are far more complaints related to taste in the aged as compared to the younger group.

2) There was no correlation between complaints referable to taste and taste perception.

3) There was no significant difference in taste perception in the older as compared to the younger age group studied.

4) Within the aged group, there was no correlation between taste perception and age or sex.

---

**Cardiac Arrhythmias in the Elderly—An Early Manifestation of Heart Failure.**

M. L. GELFAND, *Medical Post Graduate School of New York University, New York.*

Twenty elderly patients who presented themselves with various types of cardiac arrhythmias without overt signs of congestive heart failure were recently observed in private practice. There were 13 females and 7 males whose age varied from 65 to 84 years. There were 15 patients with auricular fibrillation, 2 with auricular flutter, 2 with paroxysmal auricular tachycardia, and 1 with ventricular tachycardia. The underlying heart disease in this group was as follows: 10 had hypertensive heart disease; 3 had rheumatic heart disease; and 3 had ischemic heart disease. There were 4 who had both hypertensive and ischemic heart disease combined.

The patients with auricular fibrillation and flutter were treated with digoxin by mouth; those with paroxysmal auricular tachycardia with intravenous digoxin; and the one with paroxysmal ventricular tachycardia with pronestyl. There was a good therapeutic response in about 80% of the cases. However, upon cessation of treatment recurrences of the disturbed rhythm returned. When mercuhydrin or diuril was added to the cardiotonic drugs and continued on a maintenance basis even with the omission of digitalis, there was no return of the arrhythmias.

The cardiac output was determined by the Starr formula before and after therapy and found to be diminished before therapy was begun and raised to a normal level after treatment became effective. This as well as the fact that antidiuretic therapy was successful in preventing the return of the disturbed rhythm indicate that the suddent development of a cardiac arrhythmia may be an early manifestation of cardiac decompensation even in the elderly.

---

**Meeting Basic Needs—A New Method of Approaching Geriatric Clinic Patients.**

S. GERTMAN, *Institute of Gerontology, University of Miami, School of Medicine.*

Over 50% of medical complaints of Geriatric Clinic patients derive primarily from psycho-social factors. A design has been evolved of describing such factors in a manner which is useful for diagnostic and therapeutic purposes. Case histories are presented illustrating the use of this design.

---

**Some Cardiac Parameters of Senescence.**

R. HARRIS AND C. ARAVANIS, *Ann Lee Home, St. Peter's Hospital, Albany, and the Chicago Medical School.*

As part of an investigation into the cardiac parameters of senescence 500 residents of the Ann Lee Home between the ages of 50-110 received thorough clinical examinations by an experienced cardiologist, electrocardiograms, and heart x-rays. The age distribution by

sex was almost equal. The heart murmurs increased with age until 100 years after which the incidence decreased; cardiac murmurs occurred three times more frequently in persons 90-99 years of age than in the group 50-59 years. The majority had systolic murmurs at the apex or base. The apical murmurs were more frequent. Heart size was most abnormal in persons 60-69 years of age; the percentage of normal hearts increased considerably in the groups older and younger than 60-69 years. The highest percentage of abnormal electrocardiograms (27.5%) occurred in the 60-79-year-old group. After 90, only slightly abnormal electrocardiograms were found. Auricular fibrillation was encountered in 7.4% of all cases. The incidence of complete right bundle branch system block (5.4%) was double that of complete left bundle branch block. About 6% had an old infarction. The highest incidence of hypertension was in the 60-69-year-old group; in following decades the incidence decreased, no hypertensive patients being older than 89 years. Hypertension had a deleterious effect on the electrocardiogram. Definite S-T segment and T wave changes were noted in 74.5% of the hypertensive patients. Only 24.7% had the usual pattern of left ventricular hypertrophy. The significance of these cardiac variables in senescence will be discussed.

---

**Relationship of Physical to Mental Status in Institutionalized Aged Persons.**

R. L. KAHN, M. POLLACK, I. GERBER, AND A. I. GOLDFARB, *Office of Consultant on Services for the Aged, Department of Mental Hygiene, State of New York, Queens Village.*

The purpose of this study was to evaluate the relationship of physical to mental status in aged persons in municipally licensed nursing homes, homes for the aged, and State mental hospitals.

The physical status of the individual was established by three methods. The first was a physical examination with emphasis on deriving a functional rating rather than a medical diagnosis. In the second, the performance of 10 simple tests of neuro-muscular function was objectively rated. An evaluation of the ambulatory status of the individual at the time of the examination was the third.

Mental status was determined by two procedures. The first was a specially formulated and standardized short series of questions by which the individual's orientation, memory, and range of general information could be scored. At the same time the ability to perceive two simultaneously applied tactile stimuli to the face and hands was determined. The examinations were performed by psychologists and physicians within a time span of approximately one week. More than 1500 individuals at least 65 years of age in 30 institutions were tested this way.

The comparison of individuals to each other and of the institutional populations to each other revealed a significant correlation between physical and mental status as tested. Further, a higher correlation was found between physical and mental status than between physical or mental status and the chronologic age of the individual.

The results suggest that institutions concerned with the aged, in planning their programs and facilities for care, must take into account the interdependent coexistence of physical and mental disorders in their residents and should recognize that treatment may be misguided if in approach to treatment there is an attempt to compartmentalize and separate the physical and mental aspects. Physical and mental factors in combination contribute to impaired functional status.

---

**Relation of Serum Cholesterol Level to Age, Race, and Sex in a Community Group of Elderly People.**

C. R. NICHOLS, AND W. D. OBRIST, *Center for the Study of Aging and the Department of Psychiatry, Duke University, Durham.*

In the recent literature there has been an increased interest in serum cholesterol determinations in certain disease processes. Various investigations have attempted to link evaluations of serum cholesterol levels with increased atherosclerosis.

As a part of a study on the process of aging in the central nervous system at Duke University, cholesterol determinations were done as a standard procedure on volunteer subjects over 60 years of age. Both Negro and white people from the Durham community were studied, and cholesterol determinations were related to age, sex, and race. The results tend to confirm some of the previously reported findings in the literature, while at the same time emphasizing the importance of differences in cholesterol levels between older men and women.

In this study serum cholesterol did not seem to be related to age in our subjects between 60 and 80 years. However, the analysis of the data revealed a significantly greater serum cholesterol in the Negro subjects as compared to the white subjects. In comparing serum cholesterol levels of women and men in both racial groups, it was clearly demonstrated that the women in this study had significantly higher levels than the men.

---

**Relation of EEG to Cerebral Metabolism and Organic Mental Signs in Healthy Old People.**

W. D. OBRIST, S. PERLIN, AND L. SOKOLOFF, *Department of Psychiatry, Duke University, Durham, and National Institute of Mental Health, Bethesda.*

The hypothesis was made that normal age changes in the electroencephalogram might be related to alterations in cerebral blood flow and oxygen consumption and to changes in intellectual function. Fifty-one physically healthy, non-psychotic community subjects over age 65 were studied. Cerebral blood flow and oxygen consumption were determined by the nitrous oxide technique. The subjects were evaluated psychiatrically for early signs of senile deterioration and brain syndrome. EEG's were rated clinically and subjected to a manual frequency analysis.

Mean values for cerebral blood flow and oxygen consumption did not differ significantly from those of young adults. Only 20% of the subjects had rates of oxygen utilization below the young normal range. Mild organic mental changes were seen in 23% of the sample, but only 4% gave evidence of chronic brain syndrome.

Four-fifths of the subjects had clinically normal EEG's; the remaining 20% showed minor deviations. This compares favorably with the incidence of EEG normality reported for healthy young people. However, a significant age change was found in frequency of the

dominant alpha rhythm, which had a group mean of 9 c.p.s., compared with 10 c.p.s. for young adults.

Neither cerebral metabolic function nor psychiatric status could be correlated with clinical EEG findings. In spite of an age shift in dominant EEG frequency, this variable was not related to cerebral blood flow, oxygen consumption, or evidence of early senile mental changes. A less healthy sample might have given more significant correlations, a possibility now under investigation.

---

**Vascular Replacement in Surgery.**

B. ROBERTS, *Hospital of the University of Pennsylvania, Philadelphia.*

The last decade has seen a radical change in the management of many vascular lesions because of the development of arterial grafts. Many patients who previously would have lost their limb or life are now saved by this type of surgery. The vascular lesions suitable for arterial replacement are generally either obstructive in nature or aneurysms and these tend to occur in the older age groups. The final place of arterial replacements in the medical management of patients is not yet entirely clear, but indications and contraindications for this type of work are gradually becoming better defined.

The current concept of the choice of patients with obstructive lesions who are suitable for arterial replacement is reviewed. Particular emphasis is placed on the condition of the distal arterial tree. The risks of operation and indications for operation on various arteries are outlined. Comparison of various types of arterial replacement does not yet clearly demonstrate the superiority of one type of graft or operation.

The dangers related to aneurysms of the peripheral arteries and aorta are reviewed and likewise the risks of replacement with grafts. In general operation is advised for these patients as the lesions are subject to rupture or thrombosis.

---

**Psychophysiological Response Specificity in the Elderly.**

A. J. SILVERMAN, S. I. COHEN, AND B. M. SHMAVONIAN, *Center for the Study of Aging and the Psychophysiology Laboratory, Department of Psychiatry, Duke University, Durham.*

The suggestion that the elderly have a reduced C. N. S. response capacity prompted this study, which was designed to explore sympathetic activity and C. N. S. arousal.

Ten male college students (ages 20-24) and 10 male elderly subjects (ages 60-70) were matched for physical and mental health, I.Q., and educational level. After a baseline period of galvanic skin reflex recording, a series of 84 auditory stimuli were presented at 20 sec. intervals. Stimuli included tones, neutral phrases, phrases "charged" for the young and other phrases "charged" for the elderly.

Results: a) No differences between groups were noted in latency time or in number of stimuli to which responses were given.

b) The elderly group showed decreased mean amplitude of G. S. R. as well as decreased numbers of "spontaneous" G. S. R. fluctuations. Previous as well as the present study has related this finding to decreased C. N. S. arousal, which also correlated with decreased ability to recall.

c) In spite of this over-all decreased responsivity in the elderly group, analysis of their responses to "charged" phrases, suggests that they are capable of responding. Not only did the elderly respond *more* to statements about the old (and the young group to phrases about the young); the elderly also responded more in absolute terms to these statements than did the young subjects. In other words, when the stimulus was appropriate the apparent lowered responsivity disappeared.

Lack of interest, communication problems, sociocultural problems, low motivation, and emotional difficulties could all be factors resulting in decreased responsivity and decreased C. N. S. arousal with its concomitants of reduced psychomotor efficiency and impaired recall.

In the absence of C. N. S. disease, decreased C. N. S. functioning seen in the elderly may well be more a function of the above than of minute and "subclinical" pathological changes.

---

**Aortic Thrombosis and Aneurysms in Mentally Sick Patients Over Sixty.**

G. STRASSMANN, *Laboratory of the Metropolitan State Hospital, Waltham, Massachusetts.*

Because of the increase of elderly patients in mental institutions in this country at the present time, 83% of all autopsies were performed during a 3-year period on patients over 60, with a slightly higher rate in females than in males. These patients had either been treated in the hospital for many years or were admitted recently because of atherosclerotic or senile psychoses. In both groups degenerative changes of the cardio-vascular system were common. Conspicuous was the high incidence of calcifications, ulcers, and thrombi in the abdominal aorta above the bifurcation. They produced severe abdominal symptoms, not recognized correctly before death. Bleeding into the gastrointestinal tract was observed in 30.5% of all autopsies, 10% due to acute esophago-gastro-duodenal ulcerations, 4.5% to chronic perforated or bleeding peptic gastroduodenal ulcers, 6% to mechanical intestinal obstruction, and 10% to aortic thrombi occluding the ostium of the superior or inferior mesenteric artery. Atherosclerotic aneurysms of aorta or iliac arteries were seen in 4.5%, with a predominence in males, but only one ruptured dissecting aneurysm was observed. Gangrene of the legs due to aortic thrombi extending into the iliac arteries occurred in 2.5%; 6% of all patients were diabetics.

Aortic thrombi have been removed successfully. For this reason the possibility of an aortic thrombosis with mesenteric occlusion as cause of suddenly developing severe abdominal distress in elderly psychotic patients has to be considered more often.

---

**Nutritional Status of a Group of Geriatric Clinic Patients.**

MYRNA WINNIMANN AND S. GERTMAN, *Institute of Gerontology, University of Miami, School of Medicine.*

It is commonly accepted that aged people suffer from malnutrition, especially a clinic group. Examination of a group of 60 such patients by history, physical examination, and laboratory studies fails to confirm this hypothesis.

## SECTION ON PSYCHOLOGICAL AND SOCIAL SCIENCES

*Abstracts edited by Ethel Shanas, Ph.D.*

### An Analysis of Perceptual and Mental Tests Given to Healthy Elderly Men.

JAMES E. BIRREN, JACK BOTWINICK, ALFRED D. WEISS, AND DONALD F. MORRISON, *Section on Aging, Laboratory of Psychology, National Institute of Mental Health, National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare, Bethesda.*

The purpose of the present investigation was to determine the extent of common factors in "normal" psychological aging as revealed by an analysis of intercorrelations among a broad range of measurements on a group of healthy elderly men. A total of 32 tests were administered individually requiring approximately 25 hours from each subject. Testing time for each subject was distributed over a two-week period. The tests included: simple auditory reaction time, Raven Progressive Matrices, WAIS, Wisconsin Card Sorting, speed of arithmetic operations, writing speed, verbal fluency, mirror drawing, visual judgment time, hearing loss, auditory click discrimination, binaural digit span, Stroop test of mental blocking, and learning. The subjects in this study were 47 non-institutionalized white males above the age of 65. All were healthy as judged by a comprehensive medical evaluation including a physical examination and laboratory tests. Results of the measurements were intercorrelated to yield a 32 x 32 table of intercorrelations. This correlation matrix was analyzed by Hotelling's Principal Component method and by a centroid factor analysis. The organization of mental processes in aging will be described in terms of the extent of common factors underlying the various psychological measurements.

---

### Preparation for and Participation of Volunteers in an Aged Study.

PAUL BLANK, *Social Service Department, Laboratory of Clinical Science, National Institute of Mental Health, National Institutes of Health, Public Health Service, U. S. Department of Health, Education and Welfare, Bethesda.*

There has been increasing attention to the problem of the selection of volunteers for research programs. Although there is recognition that volunteering is not co-extensive with subjects' motivations, little systematic attention has been given to the problem of preparing volunteers for a study. This paper considers relationships between the preparation of subjects and their decision to enter a study. Two further events will be explored: subjects' responses during and their reports following their participation.

Ratings were made of the decisiveness with which 26 aged subjects responded to a multi-discipline study. The subjects were divided into a decisive and an indecisive group. On the basis of a content analysis of verbatim recorded interviews the 2 groups were compared with respect to 4 characteristics: information received, expectations, understanding, and fears.

Initial findings indicate a positive relationship between the clarity of information received by subjects and their decisiveness. Detailed additional information does not influence decision making.

For most subjects expectations are multiple and range from an exclusive concern with self-benefits to a primary emphasis on contributions to society. Further, the expectations of decisive volunteers are more realistic than those of indecisive subjects which relate to differences in preparation; the indecisive group anticipate benefits clearly beyond the promise of the study.

In contrast to decisive volunteers, indecisive ones show less understanding of the purposes of the study and greater ignorance of research and give evidence of more fears about themselves in relation to the study.

Subjects' participation in and post-reactions to the study will be examined to determine the relationships of these factors to preparation.

---

### Variation in Communication Skills Among Hemiplegics.

DANIEL R. BOONE, *Department of Physical Medicine and Rehabilitation, Highland View Hospital, Cleveland.*

The purpose of this study was to investigate variations in communication skills among a random sample of 75 hemiplegic adults, mean age 61.9 years. Tests were given measuring such communication skills as listening to speech, naming, reading, writing, and conversation. Such intelligence measures as the Columbia Mental Maturity Scale and the Knox Cubes were also given. No significant relationship was found between such background variables as age, sex, education, and former occupation and performance on any of the communication or intelligence tests. Visual and auditory acuity were found to have only random influence on performance. Although a significant relationship was found between performance on communication tests and intelligence measures, isolated language deficits, such as alexia or agraphia, were occasionally found independent of over-all intellectual abilities.

A high incidence of aphasia and dysarthria was expected to be found among this adult hemiplegic sample. Right hemiplegics displayed significantly more difficulty in all communication skills than left hemiplegics, with the diagnosis of aphasia primarily confined to the 40 subjects comprising the righ hemiplegic group. Both right and left hemiplegics were found to have approximately the same degree and incidence of dysarthria (about 80% of the total sample). While language difficulties due to aphasia were clearly identified with the right hemiplegic group, dysarthria was experienced equally for both right and left hemiplegics. Apparently, the primary determinant of performance on these speech and language tests was the extent and the site of the cerebral lesion.

Hemiplegics with bilateral cerebral lesions usually presented the speech and language picture typical of their side of major involvement, i.e., right hemiplegics might show aphasia and dysarthria with left hemiplegics having only dysarthria. Suggestions for a comprehensive speech-language screening test for hemiplegics entering rehabilitation programs are given.

**Age and Productivity.**

LEONARD Z. BREEN AND JOE L. SPAETH, *Purdue University, Lafayette, Indiana and University of Chicago.*

(Abstract not received.)

---

**Factors in Criterion Measures of Adjustment of Older Adults.**

JOSEPH H. BRITTON AND W. G. MATHER, *The Pennsylvania State University, University Park.*

This investigation was conducted in order to determine factors underlying several measures of adjustment of older adults. The subjects were all persons 65 years of age and over in a rural Pennsylvania community on whom all of 6 measures of adjustment could be and were obtained (N = 123, including 48 men and 75 women).

Various methods for assessing "inner" (personal) and "outer" (social) aspects of adjustment have been utilized with 123 persons 65 and over living in their own homes in a rural community: 1) a standardized attitude inventory, 2) items concerning personal-social relations, 3) an activity inventory, 4) selected cards from the Thematic Apperception Test, 5) an opinion conformity scale, 6) ratings of interviews by judges, and 7) ratings of a sample of subjects ("Q" group) by a panel of community members. Factor analysis has been carried out on matrices of intercorrelations involving the men, women, the total group, and the "Q" group in an effort to discover the dimensions or factors underlying these criterion measures of adjustment.

Analyses showing the results of the factor analysis procedures with the adjustment criteria are presented and interpreted; some conclusions are drawn about the nature of the factors of adjustment being assessed by these measures.

---

**Regional Variation in the Pattern of Isolation of Older Persons.**

ROBERT GUY BROWN AND FRANCES C. JEFFERS, *Center for the Study of Aging, Duke University, Durham.*

It has been suggested repeatedly in the literature that aging people in American society are isolated from the rest of the social structure. One explanation of this isolation has been in terms of the pervasiveness of the conjugal family system in this country, particularly in urban areas. Grown children establish independent households and, thus, leave their aging parents, cut off from continuous family participation, to comparative loneliness.

As part of a multi-disciplinary study at Duke University, nearly 200 elderly persons living in a southeastern urban area were intensively interviewed about social factors in their life situations and their attitudes toward a variety of life experiences. Analysis of data in this exploratory study raises some questions about the inclusiveness of present formulations about isolation and suggests regional variation.

In terms of their definitions of the situation, regardless of physically separate living arrangements, the preponderance of elderly persons interviewed were not neglected or isolated by their families. A positive relationship between lack of feelings of neglect or isolation and a pattern of familism is strongly suggested. Familism—defined as the presence of frequent social contact with relatives, close family feeling, or assistance during illness—is a pattern which appears significantly more often in the Duke sample than in Albrecht's reports in Prairie City. Thus, these preliminary data would seem to indicate that in the Southeast an essentially rural pattern still survives in its urban areas, and as a result there is a minimum of isolation for its elderly people.

---

**Patterns of Successful Aging.**

EWALD W. BUSSE AND ROBERT H. DOVENMUEHLE, *Center for the Study of Aging, Duke University, Durham.*

For the purposes of studying successful aging, we have chosen to use a socio-economic definition of success. Two hundred volunteer community subjects over the age of 60 from Durham, North Carolina, were examined. The particular data of this study focused on the psychiatric aspects of these subjects' lives. Excluded from this study were all subjects whose physical or mental condition prevented their remaining in community life and those who had voluntarily removed themselves from the community by establishing residence in a retirement home.

Common conceptions of aging would lead to the conclusions that progressive deterioration in adjustment or increasing regression would occur with advancing years. From a psychiatric standpoint, our data tend in many ways to contradict such conclusions. Depressions, on the basis of evidence from histories, would seem to occur more frequently in later life. In the group above 60, however, there is no significant relationship between the occurrence of depressive episodes and age. Instead the occurrence of depressive episodes relates more prominently to socio-economic factors and the productiveness of the individual. Decrease in recent memory has also been commonly described as being closely related to increase in chronological age. Our data again indicate little influence of age per se in memory decrease in subjects over the age of 60.

Health concerns, which loom large in importance in any elderly population, are actually inversely related to age in this population. It would seem that health concerns may actually be evidence of adjustment reaction to changes in the personal and social life of the individual.

---

**Training in Social Gerontology.**

WILMA DONAHUE, *Division of Gerontology, University of Michigan, Ann Arbor, and Director, Institute of Social Gerontology.*

Social Gerontology is concerned with the behavorial aspects of aging in the individual and with the accommodation and organization of society with reference to aging and aged people within its membership. It is encompassed of the concepts and principles of sociology, psychology, anthropology, economics, and political science extended to include the total life span of man.

In order to develop a systematic arrangement of knowledge which will lead to an understanding of aging in both its individual and social aspects, an Inter-University Council of Social Gerontology, representing 16 educational institutions, was formed to promote the preparation of scientific reference works

in the field and to provide instruction for university faculty members in the behavioral and social aspects of aging. A report will be presented on the nature, content, and outcomes of the Summer Institute in Social Gerontology for university faculty members, which was held at the University of Connecticut, August 3-29, 1958. An evaluation of the Institute in relation to the findings of a nation-wide survey of current instruction in social gerontology offered in colleges and universities which has been made by the Inter-University Council will also be presented.

---

**Participation in Adult Education Programs for College Graduates in the Middle Years.**

E. A. Friedmann and William Stewart, *Department of Sociology, University of Wisconsin, Madison.*

A sample of 1300 university alumni 45 years and over was studied to determine the changes in patterns and purposes of participation in adult education programs during the later years. Participation was related to stages in work and family career lines, meanings of work and leisure, social mobility, and levels of achievement.

---

**A Test of the Generality of Beliefs and Attitudes Regarding Old People.**

Peggy Golde and Nathan Kogan, *The Age Center of New England, Inc., Boston.*

Studies of attitudes toward old people have focused on the aged as a unique group with little attempt to control for the generality of these attitudes. In the present investigation, an instrument was devised to test the hypothesis that beliefs and attitudes regarding old people are qualitatively different from those concerning the larger class of "people in general."

A sentence completion instrument was chosen in order to elicit subjects' spontaneous responses. In the "experimental" form of this instrument, the phrase "most old people" was used in the stem. The sentence stems in the "control" form were virtually identical save for the substitution of the phrase "most people." Twenty-five incomplete sentences were included in each form.

One hundred subjects, ranging in age from 17 to 23 years, were randomly drawn from the dormitories of an Eastern liberal arts college. Fifty subjects were given the "experimental" form, while the remaining 50 received the "control" form. Code categories were derived for the responses to each of the 25 stems, and 4 independent judges coded the material with a high level of agreement.

The results confirm the hypothesis of differences in beliefs and attitudes toward the two groups. A comparison of the "experimental" and "control" forms yielded statistically significant chi-squares for the large majority of items. The implications of such widely discrepant conceptions of old people and of people in general will be discussed in detail.

---

**Consumer Patterns of Aged Spending Units.**

Sidney Goldstein, *Brown University, Providence.*

In 1951 the Bureau of Labor Statistics interviewed a sample of some 12,500 family units representing all classes of consumers in urban United States. Information was obtained both on family purchases of over 1,500 items of goods and services and on income, savings, and deficits in 1950. Using these data, the Wharton School of Finance and Commerce is sponsoring a series of research monographs. One such monograph—that on "Consumer Behavior of the Aged"—is designed to ascertain how older spending units differ from other segments of the population in their income, expenditure, and savings behavior.

These data show that the income of older units is far below that of all younger age groups. Correspondingly, the expenditures of older units for all categories of consumer goods and services is markedly below those of all other age groups. Age differences also characterize the distribution of total expenditures among the various consumption items. Older units spend more for food, housing, household operations, and medical care, and less for household furnishings, transportation, clothing, personal care, and recreation. These age differences generally persist at all income levels, but tend to be much more marked among the lower income groups. The data suggest that the differential consumer behavior of the aged is a function of their over-all low income position, their limited assets and their inability or unwillingness to incur new liabilities, and the changing needs associated with the particular stage of the life cycle through which they are passing.

---

**Generational and Status Differences in the Patterning of Life Events: A Study of Middle-Aged Men.**

Bernice L. Neugarten and Kenneth M. Olsen, *University of Chicago.*

This is a study of the timing and sequence of major life events in a sample of 120 men aged 40 to 70 residing in a metropolitan area. The data deal with such events as completion of schooling, marriage, parenthood, and first and best occupational positions. Comparisons of life-lines will be made between groups born in different historical periods, groups drawn from different social class levels, and between mobile and non-mobile groups. An attempt is made to evaluate the relative importance of these generational and status factors in influencing the life patterns.

---

**Age and Religious Participation in a Large Metropolitan Area.**

Harold L. Orbach, *Division of Gerontology, University of Michigan, Ann Arbor.*

Probability samples of Detroit metropolitan area adults over the age of 21 have been surveyed since 1951 by the Detroit Area Study of the University of Michigan. A pooled sample of the studies from 1951-1957 is analyzed to provide a picture of the extent of religious participation as measured by church attendance of a cross-section of adults in a large metropolitan area.

Age and religious participation are analyzed in multivariate form by selected social variables such as religion, sex, race, ethnic background, nativity, income, education, occupation, and place and length of residence. The results are compared with the few existing studies of age and religious activity and various hypotheses concerning the relationship between age and religion are examined in the light of the findings.

**Disorientation Patterns in Institutionalized Aged Persons.**

MAX POLLACK, ROBERT L. KAHN, AND ALVIN I. GOLDFARB, *Office of the Consultant on Services for the Aged, Department of Mental Hygiene, State of New York, Queens Village.*

In patients with acute brain damage, disorientation for time, place, and person has been shown to be a meaningful pattern of adaptation rather than a simple manifestation of neurological disease. The purpose of the present study was to determine the patterns of disorientation in aged institutionalized persons and to relate these patterns to age, cultural background, and the environmental situation.

A standardized open-ended questionnaire testing orientation was given to more than 1500 persons 65 years or older in 14 nursing homes, 10 Homes for the aged, and 3 State mental hospitals.

The results indicated that in subjects over 70 years those with higher educational backgrounds were least often disoriented. Disorientation was frequently associated with poor physical functioning.

Two main patterns of disorientation were observed. A relatively small percentage showed behavior patterns commonly encountered in younger persons with acute brain disease and previously described as confabulation, identification, and reduplication. The most frequent disorientation patterns in the aged included failure to respond to the orientation questions, expressions of indifferences to where they were or the date, and "don't know" replies. Despite their disorientation many persons correctly answered questions testing general information and arithmetic ability. This type of alteration in orientation may be understood as a motivated withdrawal reaction. Such adaptive behavior was more frequent in institutions where medical treatment and rehabilitation were not active.

The findings indicate that while altered brain function is a necessary condition for changes in orientation, the extent and pattern of these changes are related to the subject's past history as well as to his immediate socio-psychologic situation and cannot be understood as a concomitant of age alone.

---

**New Group Plans to Provide Voluntary Health Insurance for the Retired: Survey of Their Characteristics.**

W. POLNER, *American Medical Association, Chicago.*

By the summer of 1957 it was estimated that 39% of all persons aged 65 years and over, or 6 million people had a form of voluntary health insurance. In the past 3 to 4 years various companies and health and welfare plans have initiated new experiments in group plans for those retiring. This paper is the result of a preliminary survey of some characteristics of these new group plans.

Some discernible facets of these recently initiated plans are:

1) All of these plans are very young; 2) most of the plans are geared to handle acute illnesses; 3) not many persons have actually retired under these plans; 4) many of these plans cover only new retirees and their dependents; 5) those retiring are still in the "young brackets," aged 65 to 69; 6) benefits are limited in one form or another; 7) subsidies are inherent in many of the plans; 8) costs are still within a reasonable range; 9) plans are subject to change; 10) some type of automatic method for payment is included in many plans; 11) only limited operating data are available.

---

**Psychosocial Studies in Geriatric Parkinsonism.**

MANUEL RIKLAN, LEONARD DILLER, AND HERMAN WEINER, *Department of Neurologic Surgery, St. Barnabas Hospital for Chronic Diseases, New York.*

During the past 4 years, detailed psychological evaluations have been performed upon several hundred Parkinsonian patients undergoing neurosurgery for the relief of tremor and rigidity. Analysis of the results for a large portion of these patients who are over 60 years of age reveals the following patterns of psycho-sociological functioning:

1) Contrary to some previous reports in the literature, a considerable portion of these patients evidence intellectual, perceptual, and cognitive impairments, and psychopathology to a degree beyond the expectations for their age levels.

2) The patient's early familial constellation plays a significant role in his perception of, responses to, and adjustment to his illness.

3) Psychopathological dynamics, adaptability, and threshold for stress are valuable prognostic indices for both adjustment to the illness and successful utilization of relief afforded by surgery.

The above findings are interpreted within a somato-psychologic frame of reference in which the reciprocal effects of somatic and psychological factors are considered.

---

**Assessment of Central Nervous System Arousal in the Elderly.**

B. M. SHMAVONIAN, A. J. SILVERMAN, AND S. I. COHEN, *The Psychophysiology Laboratory, Department of Psychiatry, School of Medicine, Duke University, Durham.*

This study was undertaken to establish possible relationships in recall and Galvanic Skin Reaction.

A group of 10 old and 10 young subjects, matched for I. Q., health, education, and sex, were exposed to 84 stimuli in 5 successive periods while continuous galvanic skin reaction records were taken. Periods 1 and 2 were tones and neutral sentences. Period 3 contained charged statements for young and old systematically associated with previous tones and sentences. Periods 4 and 5 repeated the tones and non-charged phrases in order to assess higher order autonomic conditioning if it occurred. This procedure was followed by an interview in which subjects were asked to select statements recalled from 54 phrases on cards. Number accurately recalled was used as criterion of recall.

Results of the experiment:

1) Analysis of number of responses given to specific stimuli either by periods or total experiment showed no difference between the young and old groups.

2) Mean amplitude of responses to specific stimuli was less for elder subjects than younger.

3) The total number of spontaneous fluctuations was almost twice as much for young subjects as for the old. The above two results suggest a significantly higher level of arousal for the young.

4) Rank order correlation of items correctly recalled indicated significant correlations both with amplitude of responses to specific stimuli and with number of spontaneous fluctuations, indicating a strong but not unitary relationship between central nervous system arousal and ability to recall. It is also noteworthy that the two groups overlapped considerably and that older aroused subjects showed as good a recall as younger aroused subjects, and vice versa.

In view of these findings of lower level of arousal in spite of good capacity to respond, much of the loss of memory in elderly people with no central nervous system disorders might be the result of selective inattention rather than of a reduced capacity for arousal.

---

**Reminiscences of Retirees: The Effect of the Retirement Experience on Memory of Pre-Retirement Attitudes.**

WAYNE E. THOMPSON AND GORDON F. STREIB, *Cornell University, Ithaca.*

One of the most important factors which conditions adjustment in retirement is pre-retirement anticipation of the retired status. Yet, in the absence of panel data, the reliability of indices of anticipation is questionable because the researcher must depend upon the memory of the retiree. And, the point is not that older people may not remember as well as younger people, but rather that memory may systematically be altered by retirement as it is experienced. For example, given the peculiar position of older people, reminiscence and regression may serve as more adequate adjustment mechanisms than hope or day-dreaming about the future. Thus, an analytical examination of the discrepancies between post-retirement memory of pre-retirement attitudes and actual reports made *before* retirement would serve as both a methodological and a substantive contribution. It is this problem to which the present paper is directed.

In the course of the Cornell Study of Occupational Retirement, questions have been asked of retirees which are directed specifically at their memory of their attitudes and life situation before retirement. But the study design is such that similar or the same appraisals were elicited before retirement occurred. Thus we are able to discover in which, if any, respects discrepant reports are given and, further, to relate these to aspects of the retirement situation.

The findings show an extremely large measure of consistency of response, suggesting that those investigators who rely on memory questions are for the most part on sound ground. Beyond that, differences in memory of pre-retirement attitudes can be related to differences in the retirees' responses to retirement.

---

**A Longitudinal Study of the Retirement Situation of Aged Beneficiaries of Old Age and Survivor's Insurance.**

EDNA C. WENTWORTH, *Beneficiary Studies Section, Bureau of Old Age and Survivor's Insurance, Social Security Administration, Baltimore.*

(Abstract not received.)

## SECTION ON SOCIAL WELFARE

*Abstracts edited by Walter M. Beattie, Jr., M.A.*

**The Social Worker as a Participant in Medical Care and Research on the Aged.**

LILLY HAZEL CHAFIN, *Institute of Gerontology, University of Miami School of Medicine.*

A descriptive account of the author's three years' experience as a social worker in a Geriatric Clinic will be presented. The clinic setting is an out-patient clinic of a public, teaching hospital. The clinic patients are medical indigents, 65 years of age and over. The purposes of the clinic became: 1) giving "whole" medical care, and 2) serving as a human laboratory for the Medical School's Institute of Gerotology's teaching program and its studies on aging.

The tasks of the social worker evolved into 1) receiving and orienting the new patients to the clinic, 2) obtaining a longitudinal, social history on each patient, 3) providing counseling service and physical assistance to patients as needed, 4) acting as the professional clinic person always available to patients, 5) being an observer of the continuous behavior of patients and sharing such observations with other members of the therapeutic and research teams, and 6) upon request participating in the planning and/or executing of experiments and teaching program of the Institute of Gerontology.

The functions of the social worker will be described along with her working relationship with other members of the Clinic staff. The therapeutic value of the longitudinal social history and the "accessibility" of the social worker will be discussed. Also offered are some observations on behavioral aspects of the 82 patients entering the clinic during the three-year period.

---

**The Pros and Cons of Gerontological Training as Viewed by a Social Work Practitioner.**

MARIAN EMERY, *Administrative Assistant, Family Service Bureau, United Charities of Chicago.*

This paper presents a point of view about areas in which either professional training and/or specialized training are needed by those providing social services for older people. Casework service is a professional service and requires professional training for service to any age group. Other social services *may* be given within a social service agency and not necessarily require full professional training. This paper attempts a clarification of areas in which professional training is essential and of what such training contributes to knowledge and skill in improved services. There is also a discussion of certain kinds of specialized training with or without full professional training which makes it possible to provide certain specific and well-defined services or to supplement or enrich the professional service.

The case material used, and ideas presented, are based on the experience of Family Service Bureau of United Charities of Chicago in the development of its own special project on the aged. The material presented includes not only the experience of a family casework agency, but experience in work with other community services for this age group as reflected in various kinds of cooperative relationships.

---

**Successful Aging Through Social Work.**

JEROME KAPLAN, *Executive Director, Mansfield Memorial Homes, Inc., Mansfield, Ohio.*

Unsuccessful adjustment to living conditions is considered a major focus of social welfare. This paper discusses unsuccessful aging as it becomes successful aging through the social welfare techniques of case work, group work, and community organization. Brief case histories of successes and failures are documented.

The social worker's role is 5-fold:

1. He helps the individual adjust to the changing roles foisted upon him.

2. Through involvement, he educates the organizations of society to allow an appropriate place to the older person.

3. He has the experience to suggest delineating priorities for research, thereby evolving a closer liaison between investigator and practitioner so as to make effective use of new knowledge as soon as it becomes available, make actual experiences under normal conditions available to the researcher, and point out informational lags based on direct experience.

4. He urges appropriate planning through voluntary auspices, legislation action, administrative decree, or improved working relationships.

5. He puts into practice what is produced by the researcher and legislator; the social scientist, the psychological investigator, and the medical scientist; and the planner and administrator.

And because he deals with real people—not the paper people of statistics and graphs—he is constantly concerned with terms like adjustment. Since he deals with individual variation, he consistently tests the stereotyped prototypes artificially created for convenience of communication.

---

**The Contribution of Social Work Education to the Preparation of Personnel for Service to the Aging.**

KATHERINE A. KENDALL, *Associate Director, Council on Social Work Education, New York. Paper to be presented by* GRACE WHITE, *Consultant on Educational Services, Council on Social Work Education, New York.*

No one category of professional personnel can claim a monopoly of competence in providing essential services for the aging. The knowledge and skills of various disciplines are required. Social work, in its own right and in collaborative work with other professions, is one of the disciplines which can make a specific and major contribution to this growing field of service. The professional preparation required by the social worker for work with the aging is provided by graduate schools of social work. Through a two-year educational program comprising both theory and supervised field practice, the social work student acquires a basic body of knowledge about social welfare organization and services and individual, group, and community behavior; develops basic skills in the use of the helping process whether directed toward work with individuals, groups or communities; and becomes identified with the goals, values and ethics of professional social work practice. Within this context of basic professional education for social work, content necessary to provide effective social work service to the aging can be effectively incorporated into the total curriculum, without recourse to narrow specialization or specifically-focused vocational training.

---

**Local Committees on Aging in Michigan.**

ANTHONY LENZER, *Executive Secretary, Michigan Legislative Advisory Council on Problems of the Aging, Ann Arbor.*

This paper deals with the origins, structure, and activities of local committees on aging in Michigan and is based on a survey conducted by the author. Data were obtained by a questionnaire which was filled out by the chairman of each local committee. The survey was a project of the Legislative Advisory Council on Problems of the Aging and was designed to facilitate an exchange of information between existing groups and to assist other groups seeking guidance in the development of new programs for older people.

Some of the main findings are as follows: The 9 presently-operating committees were established in the past 5 years; all are found in the heavily-populated urban areas of the state. Functions stressed are community education on aging, coordination of programs, and provision of information and referral services. Groups are typically organized by voluntary organizations and receive financial support from such organizations. Four groups have full-time staff; most utilize the efforts of volunteer members through a variety of sub-committee projects. Public forums on aging, workshops, discussion series and formal courses, and television series are the most popular committee activities. Several committees have conducted local surveys.

The paper concludes by raising certain questions about the direction of future development of community programs for older people.

---

**Trends in Care of the Non-Psychotic Aged in an Institutional Setting.**

MAURICE E. LINDEN, M.D., *Director, Division of Mental Health, Department of Public Health, City of Philadelphia.*

The realization that institutionalization possesses an intrinsic factor of regimentation and depersonalization has led to program reforms throughout the country. "Institutional adjustment" is recognized as an insidious development which tends to neutralize many of the potential benefits to be derived from group care. Hence the newer approaches to institutional care embrace revisions in a) philosophy of program, b) architecture, c) concept of resocialization, d) services to families and social contacts, e) medical programs, f) individuation of service policies, g) community-institutional contact, h) aspects of self-government, and i) uses of leisure. Properly organized programs in well-run institutions are readily demonstrable as preventive mental health measures. Prevention of the emotional indispositions of aging among institutionalized oldsters requires the application of a paradoxical principle of care: fostering naturalness and familiarity in an unnatural setting.

**The Future of Institutional Programs for the Aging.**

ROBERT MORRIS, *Consultant, Social Planning, Council of Jewish Federations and Welfare Funds, Inc., New York.*

A preliminary report on a national study of 70 sectarian homes for the aged will be presented. The data points to a major shift in program development and direction by these institutions, which constitute one of the major community resources for services to the aged. The study indicates the extent to which these institutions have, in fact, responded to changing needs of the aging population, the current processes for further change in program, and the degree to which scientific and professional thinking has been translated into practice.

The likely evolution of gerontological centers and the clarification of agency responsibilities will be discussed. Special attention will be paid to the distinction between the emerging medical and nursing responsibilities of these institutions and their traditional functions of housing, social, and custodial care.

Study data will include: nursing and medical requirements of residents of homes for the aged, comparisons with other chronic disease institutions, and patterns for the development of institution-based programs of day care, boarding care, home care, employment, and research.

---

**Social Work Education: Knowledge for Use in Working with the Aged.**

DOROTHY SUMNER, *Associate Professor, New York School of Social Work, New York.*

(Abstract not received).

---

**Emerging Definitions and Classifications of Nursing Homes and Their Services.**

BRUCE UNDERWOOD, *Medical Director, Consultant in Nursing Home Services, Chronic Disease Program, Division of Special Health Services, P.H.S., D.H.E. &W., Washington, D. C.*

(Abstract not received).

---

**The Contribution of Social Work Education to the Preparation of Personnel for Service to the Aging.**

GRACE WHITE, *Consultant on Education Services, Council on Social Work Education, New York.*

(See Kendall, K. A.)

## SCIENTIFIC EXHIBITS

*Abstracts edited by Leo Gitman, M.D.*

**Aids for the Care of the Cardiac.**

*American Heart Association and the Heart Association of Southeastern Pennsylvania.*

This exhibit shows two of the many ways in which the Heart Associations assist both physicians and patients.

"Here's Help for the Sodium-Restricted Patient" is a joint project of the American Heart Association and the U. S. Public Health Service. It features 3 sodium-restricted diet booklets and 12 slides calling attention to "hidden sources" of sodium. This is a part of our program to aid physicians.

"Here's Help for the Activity-Restricted Housewife" is an example of the Heart Association of Southeastern Pennsylvania's work simplification program. Because of the high incidence of cardiac disease in older women, the need for a program of rehabilitation encompassing the sociological, psychological, and medical aspects of their problems is obvious.

Work simplification is conducted by home economists, trained by Dr. Mary H. Easby, for patients, nurses, and women interested in saving energy.

---

**Protein and Amino Acid Needs in Nutritional Stress of the Aged.**

ANTHONY A. ALBANESE, REGINALD A. HIGGONS, AND LOUISE A. ORTO, *St. Luke's Convalescent Hospital, Greenwich, Connecticut, and St. Luke's Hospital, New York.*

Findings of extended studies indicate that the healthy aged are able to sustain themselves in good nutritional status on a daily minimum intake of approximately 54 Gm. of protein in a self-selected diet of about 1,560 calories. Under conditions of nutritional stress from any cause, however, this intake of proteins is insufficient for rapid repletion. In order to speed up tissue regeneration in metabolically normal old people convalescing from illness or surgery, it has been found desirable to encourage consumption of at least 1.5 Gm. of protein per kilo per day, with 30% in the form of meat. When dietary preferences or poor appetite interfere with this practice, administration of 600 to 900 mg. of L-lysine per day, divided between meals, has been found to offer an effective supplementary means of hastening reconstruction of essential tissues.

---

**American Medical Association Committee on Aging.**

The exhibit is concerned primarily with outlining the major challenges to the medical profession in the field of aging and the aged.

A portion of the exhibit is devoted to a graphic presentation of how the problem of aging has grown and various broad elements that relate to it.

The balance of the exhibit relates to the following challenges for the medical profession created by the problem of aging and the aged:

1) To seek public acceptance of a proper perspective toward older citizens.

2) To promote health maintenance and restorative services.

3) To encourage the training of personnel and the development of facilities for the care of the aged.

4) To cooperate in developing community programs for the senior citizens.

5) To expand medical and socio-economic research in reference to aging and the aged.

6) To improve methods of financing health care for the aged.

**Philadelphia Pulmonary Neoplasm Research Project.**

KATHARINE R. BOUCOT, DAVID A. COOPER, WILLIAM WEISS, THOMAS F. NEALON, JR., DONALD J. OTTENBERG, AND PETER A. THEODOS, *Philadelphia Pulmonary Neoplasm Research Project.*

Eighty-three proved cases of primary bronchogenic carcinoma have been found among 6137 men 45 years of age and older who have been X-rayed and questioned in regard to symptoms every 6 months over a 2 to 6-year follow-up period. The exhibit presents an analysis of these cases according to source of referral, age, race, smoking habits, initial chest X-ray, and symptoms. The exhibit shows X-rays and summaries of several cases of proved bronchogenic carcinoma among 17 men who developed lung cancer after entry into the Project.

---

**Well-Rounded Geriatric Program.**

*Home for the Jewish Aged, Philadelphia.*

The exhibit will show the various services rendered at this Home indicative of a well-rounded geriatrics center. The medical, research, auxiliary, religious, and employment services will be demonstrated by means of photographs and transparencies. An artist's rendering of York House, which is to be an 11-storied apartment house for the elderly, will also be shown. Some of the reprints of reports of the work done at the Home and a summary of the medical and social research presently under way will be available.

---

**Activities of the Division of General Medical Sciences and the Center for Aging Research.**

G. HALSEY HUNT, ROBERT P. AKERS, AND STANLEY R. MOHLER, *National Institutes of Health, Bethesda.*

The exhibit consists of three panels:

The middle panel depicts the relationship of the Center for Aging Research to other Department of Health, Education, and Welfare activities in the field of aging.

The left panel describes the scope of the interests covered by the Division of General Medical Sciences, of which the Center for Aging Research is one of three operating units.

The upper half of the right panel describes the role played by the Center for Aging Research within the Institutes. The lower half presents a flow chart which illustrates the processing of Public Health Service research and training grant applications.

---

**Half of All Cancer Involves Sites Accessible to Direct Examination.**

RAYMOND F. KAISER, *National Cancer Institute, Bethesda.*

This exhibit points out the accessible cancer sites in both sexes which can be examined by the physician in his office. The percentages of all cancer occurring in these sites are given.

---

**Use of Ganglionic Blocking Agents in Hypertension.**

JOHN H. MOYER, JOHN R. BEEM, JOSEPH B. ROSENFELD, AND JAMES B. DONALDSON, *Hypertension Unit, Hahnemann Medical College, Philadelphia.*

The exhibit shows survival rate in patients with malignant hypertension, as well as in typical untreated patients with malignant hypertension showing progressive vascular deterioration, together with incidence of some symptoms and signs in patients with hypertension, and the beneficial effects of anti-hypertensive therapy. A diagram of vasoconstrictor impulses traveling over the sympathetic nervous system of a normal, hypertensive and treated patient is included. Clinical considerations in the use of ganglionic blocking agents are presented with blood pressure response and side effects of therapy. A diagram of the autonomic nervous system shows ganglia and the location of the various types of drugs used to accomplish pharmacological blockage.

---

**Mental Health.**

*National Institute of Mental Health, Bethesda.*

Pamphlets, reprints, bibliographies, and reports dealing with the mental health aspects of aging will be available for free distribution.

---

**Growth of the Incisor Teeth in Different Age Groups of the Guinea Pig.**

JAMES B. ROGERS, WALTER L. JOHNSON, AND JOHN H. ROGERS, *University of Louisville School of Dentistry.*

Measurements (postmortem) were made of the incisor teeth of the guinea pig in various age groups to determine the difference in size (chart 1). On the basis of recorded age, we have classified our animals in the following age groups: young, 1-365 days; mature, 366-730 days; old, 731-1095 days; senile, 1096 or more days.

Continuous growth of the teeth was observed in the different groups of living guinea pigs kept under relatively constant dietary and environmental conditions. These teeth were notched on the labio-cervical surface and measurements were recorded weekly from the notch to the crest of the gingiva (chart 2).

It was concluded from these measurements that the teeth reach full size by the first year and continue to grow at a rapid rate of about 2 mm. per week throughout life. Thus the rapid growth compensates attrition, maintaining the teeth at a constant level during life of the animal.

---

**Treatment of Gangrene of the Extremities in the Aged.**

SAUL S. SAMUELS, *Brooklyn Hebrew Home and Hospital for the Aged.*

The exhibit consists of a series of enlarged photographs (some in color) illustrating the steps in the treatment of arteriosclerotic and diabetic gangrene and charts outlining details of conservative methods of treatment. Operative methods preferred, when indicated, are given.

---

**Creative Activity—Day Centers—New York City.**

*Sirovich Day Center of the Department of Welfare and private sponsoring group, New York.*

The exhibit includes paintings by members of the Day Center, whose average age is 74 and who have never painted before, ceramics, hand-turned and on

the wheel, and baked and glazed in the Center, basketry, sewing, and boxes, all made at the Center.

One of the primary aims of the Day Center Program is to develop a spirit of fellowship wherein the members will find, through activity programs and committees, the cultural, educational, and recreational interests so many people fail to develop throughout their lives. The member is given the opportunity to use and express skills and talents of which he may have been completely unaware. Through the interest, acceptance, and recognition afforded him, he gains a feeling of adequacy, security, respect, and continued usefulness to himself and the community.

The program is organized on a group work basis through committees wherever possible in order to encourage maximum participation. Essentially it is a mental health and adult education program which promotes the social and emotional adjustment of the older person, giving him companionship and activity in an environment favorable to his continued growth.

---

**Bone Growth and Development in Terms of Cytological Changes of Aging Osteoblasts.**

E. A. TONNA AND N. PILLSBURY, *Department of Histo-Cytochemistry, Hospital for Special Surgery, New York.*

The exhibit represents a study of population and cytological changes in the periosteal osteoblasts of rat femora from birth to old age. Comparisons are made to the respiratory enzyme activity (cytochrome oxidase and succinic dehydrogenase) of these cells and to the biochemical significance of the observed changes to the physiology of bone growth and development.

The results indicate that active osteoblasts are present in large numbers up to 8 weeks of age, falling sharply thereafter. Mitochondrial counts reveal one-half of the number found at 5 weeks of age. The mitchondrial number per cell becomes less with increasing age. These changes parallel observations made on respiratory enzymes.

Support is given to previous findings that observed changes in bone growth and development are associated with changes in osteoblastic activity and that the reduction in osteoblastic population and morphology follow changes noted in the mitochondrial complement of these cells and their associated respiratory enzymes.

---

**Senior Citizens Hobby Show.**

ERNESTINE H. VILLALON, *The Emergency Aid of Philadelphia.*

A panorama of the Senior Citizens Hobby Show will be presented.

# Technical Exhibits

*Abstracts edited by Leo Gitman, M.D.*

**Darwin Laboratories.**

LH 400 (Lipo-Hepin), sodium heparin, U.S.P. 400 mg. per cc., allows a significant increase in efficiency of anticoagulant and lipoprotein lipase response. Administration and control problems usually associated with heparin therapy are essentially eliminated. Other heparin concentrations and other products will be discussed.

---

**Desitin.**

Desitin Ointment, the pioneer cod liver oil ointment, is now available as Desitin Powder.

The following preparations have been formulated for special therapeutic application: Desitin Hemorrhoidal Suppositories, and Rectal Ointment; Desitin Baby Lotion; Desitin Acne Cream; Desitin Cosmetic and Nursery Soap.

---

**Doho Chemical Corporation.**

The following products will be presented: Auralgan, Otosmosan, Rhinalgan, and New Larylgan for ENT conditions. Turgasept, an ionic deodorising aerosol, neutralizes odors without floral masking or odor substitution. Recommended for use in hospitals, nursing homes, animal clinics, etc.

Mallon Chemical Corporation, a subsidiary, will feature Rectalgan (liquid) and Dermoplast (aerosol) topical anesthetics.

---

**Knoll Pharmaceutical Company.**

Vita-Metrazol is now available in tablets as well as elixir form. Vita-Metrazol is indicated for all age groups. It is useful in raising the mood, decreasing confusion and memory loss, improving the appetite and sleep pattern, and overcoming untidy habits including incontinence. Vita-Metrazol combines the stimulant action of Metrazol together with prophylactic amounts of selected vitamins.

Information concerning Vita-Metrazol as well as Quadrinal, Dilaudid, and other Knoll preparations is available for your review at our Exhibit.

---

**Medco Products Co.**

Presenting the Medco-Sonlator: a new concept in therapy that combines electrical muscle stimulation and ultrasound simultaneously through a single Three-Way Sound Applicator. The Medco-Sonlator is a distinct advance in the effectiveness of physical therapy in your office or hospital. A few minutes spent in our booth will prove of value to you as a gerontologist.

# GERONTOLOGICAL RESEARCH ACTIVITIES OF THE ORGANIZATION FOR HEALTH RESEARCH T.N.O. IN THE NETHERLANDS

R. J. VAN ZONNEVELD, M.D.

In the Netherlands, according to the Act of Applied Scientific Research of 1930, several specific organizations have been set up at the suggestion of or in consultation with the Central Organization for applied scientific research "to promote applied research and make its results available to all in the most effective manner" (9). The youngest of these organizations, the Organization for Health Research T.N.O., started to function in 1950. Deriving its support from the State, this Organization, in close co-operation with the universities, promotes research which is considered to be of benefit to the general state of health of the Dutch population.

In 1952 the Governing Committee of the Organization for Health Research T.N.O., having obtained some individual applications for investigations in the field of gerontology, decided to nominate an advisory committee for gerontologic problems. Members of this committee were: the chairman and secretary of the Organization, two professors of social medicine, a professor of psychiatry, a professor of morbid anatomy, a professor of public health, a senior general physician from a University hospital, and a provincial medical officer of health.

This committee started by reviewing the applications for subsidies, but it soon concluded that the Organization for Health Research T.N.O. had a major task in promoting gerontologic research (3). While on the one hand, the absolute and relative number of the aged in the Netherlands was increasing continuously, on the other, gerontologic investigations were found to be scarce.

Consequently the advisory committee considered it important to initiate such research under its own auspices. Various projects have been initiated in university and other scientific institutes as well as in the community. The co-ordination of these investigations has been insured by a co-ordinating physician and a medical adviser.

Among the first investigations, which were subsidized by the Organization for Health Research T.N.O., but which actually had started before the advisory committee took office, were:

1. experimental gerontologic research in the Antonie van Leeuwenhoek-Huis (the Netherlands Cancer Institute),
2. a socio-medical survey of the state of health of 3000 aged persons in the town of Groningen,
3. a detailed investigation of a medical practice dealing with elderly patients,
4. biochemical studies of the composition of lipoproteins, as part of the study of atherosclerosis.

The last named study will not be discussed here since a special advisory committee has now been organized to promote research in atherosclerosis. The third study yielded no results of importance.

In 1952 the reviewer surveyed the socio-medical conditions of 3000 people 65 years and over living in Groningen (20, 22, 23, 28, 29). The statistical evaluation of the data obtained was made possible by a grant-in-aid from the Organization for Health Research T.N.O. Some results were: with increasing age the percentage of people complaining of their health remained the same; in all age-groups there were significantly more women than men with complaints about their state of health; constipation formed one of the most frequent complaints; about ⅔ of the aged had been treated by a doctor within the last three months before the inquiry. A simple memory test showed a significant decrease with age (25). Nearly ½ of the men and ¼ of the women were considered to be fit to live in their own home if regular housekeeping assistance was provided. Of 1000 aged persons, 153 were deemed in need of residential home care and 34 in need of nursing home care, based only on the personal condition of the aged.

Other projects sponsored by the Organization for Health Research T.N.O. include the following:

*Research on nutritional factors.* In the Netherlands Institute for the People's Nutrition, van der Rijst and Jansen, the latter the well-known scientist who synthesized vitamin $B_{12}$, studied the effects of variations in diet on longevity and pathologic lesions in rats (7). Animals were permitted to live their life span and were autopsied at death. A high incidence of otitis media and ulcus of the hind-legs was observed. Animals fed *ad lib.* showed a higher incidence and greater severity of pathologic lesions of the kidneys and liver than did the animals fed a limited diet. In contrast, animals on restricted diets showed a higher incidence of pathology of the islets of Langerhans than did the well-fed animals. Male rats fed *ad lib.* showed the shortest life span and the most severe kidney lesions.

In the Antonie van Leeuwenhoek-Huis at Amsterdam important experimental investigations in gerontology are in progress. The purebred strains of mice and rats raised under standardized conditions in this Institute offer useful material for research on the processes of aging. Thung, working with Mühlbock, has shown a reduction in the response of vaginal tissue of castrated female mice to the administration of oestrone with increasing age. The decreased vaginal reaction was related to renal disease in the aged animals.

Thung (10) found that although many old mice retained adequate renal function, as indicated by histologic sections, some developed characteristic evidence of amyloid papillonephritis. The pathologic changes were associated with a decreased urinary protein content (11). The problem of the formation of amyloid in aging animals was also studied extensively (14, 15, 16).

At the same time the investigations of the female sex organs of the mouse were continued (6). Mühlbock presumed from his findings that the susceptibility of the uterus to oestrogenic hormone does not, with increasing age, decrease to the same extent as that of the vagina (5). The marked hypertrophy of the uterus in old animals is thus attributable to the increased oes-

trone level in old age, as this phenomenon could be demonstrated (19). Thung made further comparative gerontologic studies of the mouse ovary (12, 13, 17, 18). He deduced from these that the basic processes of senile involution of the ovaries in mice and women are highly comparable, if allowance is made for the differences in structural and temporal relations. Investigations are continuing with respect to mouse adrenals and the influence of other endocrine glands, as the hypophysis, on the old-age changes in the organs mentioned.

Bronts and van Zonneveld (1, 2, 21) have analyzed the impact of aged patients on hospital beds. The numbers, the duration of stay and the diagnoses of patients 65 years and over, who had been admitted to various hospitals in The Netherlands on 4 sample days in 1924, 1939, and 1954 (21 hospitals) were compared. Some of the major findings were: the percentage of aged patients in the total hospital population increased from 7 to 10 to 16 in these years; no remarkable seasonal influence on the admission rates could be demonstrated; the median length of stay of people 65 and over was 43 days in 1954 and 53 days in 1939, i.e., two to three times larger than for younger age groups; the most frequent discharge diagnoses were malignant neoplasms, heart diseases, and accidents.

The medical and socio-psychologic survey of the aged conducted with the co-operation of about 370 general practitioners is now entering its final stages (4, 24, 27). More than 3000 people of 65 and over, selected at random from each participant's practice, were carefully examined and interviewed by their own doctor in order to obtain a well-founded insight into their state of health. Each examination took about three hours and a great variety of data were collected on the physical, mental, and social conditions. These data are in the process of statistical evaluation.

Finally, there is a group of investigations which have only been started a year or somewhat more ago, and which will be continued for some time to come. They are:

1. An experimental investigation to try to develop and validate an intelligence test for aged and adult people at the Institute of Psychology of the University of Groningen.

2. Combined medical, pathologic, sociologic, and psychologic investigations in the 400 inmates of a large institution for the aged at Rotterdam. In addition, several laboratory tests are carried out, as for instance: 17-Ketosteroids, Ca, P, cholesterol, bloodsugar. Various specialists are performing other specific tests. For example, a cardiologist records ECGs at rest and sometimes with exertion, an ophthalmologist examines the retinal fundus, and an otorhino-laryngolist takes audiograms. A psychologist will do some simple tests. Autopsies are also performed, in which special attention is paid to the adrenals.

3. A medical examination of the 700 to 800 inmates of the municipal home for the aged at Amsterdam. The same forms as used by the general practitioners in their survey and in the Rotterdam project are used for their medical examination. Besides these investigations a special examination of the prostate is carried out by an expert from the Cancer Institute.

4. A statistical evaluation of the mortality of the older age groups in several areas of the Netherlands in different periods is in progress.

5. Finally, an investigation of the role of nutrition in the origin of senile osteoporosis is under way under the direction of Groen. For this purpose also, a comparative study of the citric acid metabolism in patients with various skeletal diseases will be made, besides the investigation by bone biopsies.

In addition, a number of small studies concerned chiefly with nutritional field studies on chronic diseases in old people have been completed (8) as well as a medical evaluation of certain facilities in residential homes (26).

REFERENCES


1. Bronts, H. J., and Zonneveld, R. J. van: (A Survey into Number, Length of Stay and Diagnosis of Aged People Admitted to a Number of Hospitals in 1924, 1939, and 1954) with an English summary. *Het Ziekenhuiswezen, 30:* 305-314, 1957.
2. Bronts, H. J., and Zonneveld, R. J. van: *The Impact of Aged Patients on Hospital Care.* Paper presented at the Fourth Congress International Gerontological Association, Merano, 1957.
3. Groen, J.: (Gerontology, a New Field of Activities of the National Health Research Council T.N.O.). *T.N.O.-Nieuws, 8:* 403-409, 1953.
4. Groen, J., and Zonneveld, R. J. van: (Gerontological Research by the National Health Research Council T.N.O. Gerontological Investigations by General Practitioners). *Medisch Contact, 10:* 76-78, 1955.
5. Mühlbock, O.: Hypertrophic Secondary Sex Organs in Very Old Female Mice. In: *Old Age in the Modern World.* E. and S. Livingstone, Ltd., London, 1955, pp. 199-202.
6. Mühlbock, O.: (Degenerate Growth and Aging). *Ned. T. v. Geneesk, 101:* 1383-1384, 1957.
7. Ryst, M. P. van der, and Jansen, B. C. P.: Influence of Diet and Age on Old Age Changes of the Organs of the Albino Rat (unpublished data).
8. Schreuder, J. Th. R.: (Chronic Diseases in the Aged). *T. v.* Geneesk., 33: 119-137, 1955.
9. *The T.N.O. Guide, Central National Council for Applied Scientific Research in The Netherlands T.N.O.,* 5th ed., The Hague, 1955.
10. Thung, P. J.: Age Changes in the Mouse Kidney. In: *Old Age in the Modern World.* E. and S. Livingstone, Ltd., London, 1955, pp. 150-155.
11. Thung, P. J.: Proteinuria in Mice and Its Relevance to Comparative Gerontology. In: Experimental Research on Aging, Experientia supplementum IV, Birkhäuser Verlag, Basel-Stuttgart, pp. 195-198.
12. Thung, P. J.: The Senile Mouse Ovary and Its Relevance to Comparative Gerontology. In: *Experimental Research on Aging,* Experientia, supplementum IV, Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 74-77.
13. Thung, P. J.: (Comparative Old Age Studies of Mouse Ovaries). *(6th Yearbook of Cancer Research and Cancer Fight in the Netherlands)* 1957, pp. 44-50.
14. Thung, P. J.: The Relation Between Amyloid and Aging in Comparative Pathology. *Gerontologia, 1:* 234-254, 1957.
15. Thung, P. J.: Senile Amyloidosis in Mice. *Gerontologia, 1:* 259-279, 1957.
16. Thung, P. J.: Amyloid and Ageing. *Fourth Congress, International Association of Gerontology, Merano, 1957, Abstracts,* p. 269.
17. Thung, P. J.: (Ovaries of Old Mice, a Comparative Study). Dissertation, Leiden, 1958.
18. Thung, P. J., Boot, L. M., and Mühlbock, O.: Age Changes in the Ovaries of Mice. *Ned. T. v. Geneesk., 99:* 3231, 1955.
19. Thung, P. J., Boot, L. M., and Mühlbock, O.: Senile Changes in the Oestrous Cycle and in Ovarian Structure in Some Inbred Strains of Mice. *Acta endocrinol., 23:* 8-32, 1956.
20. Zonneveld, R. J. van: *(Health Problems of the Aged. Results of a Sociomedical Survey of 3000 People of 65 and Over in the Town of Groningen)* with an English summary, graphs and tables. Kon v. Gorcum en Comp., Assen, 1954.
21. Zonneveld, R. J. van: (Aged Patients in Hospitals). *Het Ziekenhuiswezen, 28:* 108-113, 1955.
22. Zonneveld, R. J. van: (Health Problems of the Aged). *Geneesk. Gids,* 33: 45-53, 1955.
23. Zonneveld, R. J. van: Health Problems of the Aged. In: *Old Age in the Modern World.* E. and S. Livingstone, Ltd., London, 1955, pp. 349-353.
24. Zonneveld, R. J. van: Gerontological Activities in the Netherlands. *J. Gerontol., 11:* 213-214, 1956.
25. Zonneveld, R. J. van: An Orientation Study of the Memory of Old People (in press, *Geriatrics).*
26. Zonneveld, R. J. van: (Separate Lavatories in Residential Homes?) (in press, *Bouw).*
27. Zonneveld, R. J. van, and Groen, J.: A. Comprehensive Study of the Aged by General Practitioners. Paper presented at the Fourth Congress, International Association of Gerontology, Merano, 1957.
28. Zonneveld, R. J. van, and Polman, A.: (Life Span and Heredity). *T. v. Soc. Geneesk.,* 33: 185-187, 1955.
29. Zonneveld, R. J. van, and Polman, A.: Heredity Factors in Longevity. *Acta genet. et statist. med. 7:* 160-162, 1957.

# INDEX TO CURRENT PERIODICAL LITERATURE

NATHAN W. SHOCK
*Gerontology Branch*
*National Heart Institute*
*National Institutes of Health*

THE SUBJECT categories are those in *A Classified Bibliography of Gerontology and Geriatrics* by Nathan W. Shock published by Stanford University Press, Stanford, California (1951). Only major headings are used and Roman numerals correspond to those given in the bibliography. In so far as possible, references are classified according to organ systems. Thus, most of the material on Geriatrics will be found under the organ system involved in the disease. Cross references are indicated by number at the end of each section. When available, abstract references are given (*B.A.—Biological Abstracts: P.A.—Psychological Abstracts*, and *P.I.—Population Index*). Abbreviations for journals are those used in *A World List of Scientific Periodicals Published in the years 1900-1933, 2nd Edition*. For journals not listed, abbreviations were devised according to the general rules used in the above source. It is impossible to cover all journals and list all papers concerned with aging and the aged. Authors and publishers are requested to call attention to publications or to send reprints to the Gerontology Branch, Baltimore City Hospitals, Baltimore 25, Maryland. The assistance of the Forest Park Foundation, Peoria, Illinois, in the preparation of these materials is gratefully acknowledged.

## GERONTOLOGY

24307. American Psychological Association. Division 20. Maturity and Old Age: Program (with abstracts) of 1958 meeting. *Amer. Psychol., 13:* 341-342; 348; 352-353; 354, 1958.

24308. Birren, J. E.: Why study aging? *Amer. Psychol., 13:* 292-296, 1958.

24309. Brožek, J.: Biology of human aging. *Newsletter (Geront. Soc.), 5:* 7; 11, March 1958.

24310. Cabot, H.: The Age Center of New England, Inc. *Newsletter (Geront. Soc.), 5:* 9; 11, March 1958.

24311. Crane, H. R., and J. B. Griffin: University of Michigan radiocarbon dates. II. *Science, 127:* 1089-1105, 1958.

24312. Desmond, T. C. (Chairman): *Good news for later life.* N. Y. State Joint Legis. Commit. on Probl. of Aging, Legis. Doc. No. 8, 1958, 169 pp.

24313. The Gerontological Association of Japan: *The Second Annual Reports of the Gerontological Association of Japan.* The Association, Tokyo, 1957, 393 pp.

24314. International Association of Gerontology. Social Science Research Committee: *The need for cross-national surveys of old age.* Div. of Geront., Univ. Mich., Ann Arbor, 1957, 77 pp.

24315. Jones, H. E.: (Consistency and change in early maturity.) *Vita Humana, 1:* 43-51, 1958.

24316. Jones, H. E.: The Oakland growth study; fourth decade. *Newsletter (Geront. Soc.), 5:* 3; 10, March 1958.

24317. Kaplan, J.: *Aging is everyone's concern; proceedings of the First Ontario Conference on Aging.* Dept. of Extension, Univ. Toronto, 1957, 208 pp. Abstr: *Geriatrics, 13:* 60A, 1958.

Published on a grant from the Forest Park Foundation to the Journal of Gerontology.

24318. Lewis, W. H., Jr.: Medicine and the aging population. *J. Amer. med. Ass., 166:* 1412-1419, 1958.

24319. Lubovsky, V. I., and A. I. Meshchetiakov: (A conference on the problems of age (age morphology, physiology and biochemistry)). *Probl. Psychol., U.S.S.R.*, —: (3), 180-183, 1957.

24320. Naldrett, S. N.: Half life of rhenium and ages of minerals. *Ann. N. Y. Acad. Sci., 72:* (Art. 5), 215-226, 1958.

24321. Piantoni, G. G. H., and S. Tarnopolsky: La Gerontologia e Geriatria nei Congressi; Giornate di Gerontologia e Geriatria della Società Argentina. *Riv. Geront. Geriat., 7:* 74-76, 1958.

24322. Rubin, M., and C. Alexander: U. S. Geological Survey radiocarbon dates. IV. *Science, 127:* 1476-1487, 1958.

24323. Sotgiu, G.: Giornate Geriatriche di Montecatini Terme. *Riv. Geront. Geriat., 7:* 77-78, 1958.

24324. Soule, G.: *Longer life.* Viking Press, New York, 1958, 151 pp.

24325. Trojan, J.: (New conception of gerontology.) *Čas. Lék. čes., 97:* 65-67, 1958.

24326. Washington (D. C.). Federal Council on Aging: *Aiding older people.* The Council, Washington, May 1958, 34 pp.

24327. Anonymous: Institute for Social Gerontology announces awarding of 36 faculty fellowships for summer 1958 course. *Newsletter (Geront. Soc.), 5:* 1; 10, March 1958.

See also Nos. 24825, 24841.

## BIOLOGY OF AGING

### I. CELLULAR BIOLOGY AND PHYSIOLOGY (includes plants)

24328. Carles, J.: (Formation of organic acids by maize.) *Bull. Soc. Chim. Biol., Paris, 39:* 1177-1182, 1957. Abstr: *Biol. Sci., 10:* No. 1526, 1958.

24329. Chvapil, M.: (Fibroplasia. IV. Scleroproteins in lungs, liver, kidneys, and myocardium during ontogeny in rats. *Physiol. Bohemoslov., 6:* 102-110, 1957. Abstr: *Biol. Sci., 9:* No. 588, 1958.

24330. Chvapil, M., and Z. Hrůza: (Studies in fibroplasia. VII. Influence of underfeeding and diets with varying protein content on amount of organ scleroproteins in rats under conditions of physiological fibroplasia.) *Physiol. Bohemoslov., 6:* 316-323, 1957. Abstr: *Biol. Sci., 10:* No. 341, 1958.

24331. Coffman, F. A.: Cold-resistant oat varieties also resistant to heat. *Science, 125:* 1298-1299, 1957. Abstr: *Biol. Sci., 8:* No. 6175, 1958.

24332. Fergus, C. L., and H. Cole, Jr.: Longevity of the oak wilt fungus stored under mineral oil. *Phytopathology, 45:* 405, 1955. Abstr: *B. A.,* 30: No. 11501, 1956.

24333. Gordon, M. W., and J. I. Nurnberger: Acute cold-induced changes in cellular protein and nucleic acids in rat liver and brain; a description and critique of biochemical and cytochemical studies. *Exp. cell. Res., 8:* 279-304, 1955. Abstr: *B. A., 30:* No. 15736, 1956.

24334. Gupalo, P. J.: (The problem of senescence and rejuvenescence of plants and its importance in plant breeding.) *Bull. Moscow Soc. Stud. Nature, 62:* (5), 77-92, 1957. (English summary).

24335. Heine, U. I., and E. Parchwitz: Explanationsversuche am Herzen und an der Haut verschieden alter Mäuse. *Arch. Geschforsch., 11:* 111-114, 1957.

24336. Howard, F. D., and M. Yamaguchi: Respiration and the oxidative activity of particulate fractions from developing pepper fruits *(Capsicum annuum.* L.). *Plant Physiol., 32:* 418-423, 1957. Abstr: *Biol. Sci., 10:* No. 1517, 1958.

24337. Kazarjan, V. O., and E. S. Avundzhjan: (The ontogenetic change of the photosynthetic activity in the tree's leaves.) *Repts. Armenian Acad. Sci., U.S.S.R., 25:* (3), 155-160, 1957.

24338. Kilpatrick, R. A.: Longevity of *Cercospora kikuchii* on soybean stems. *Phytopathology, 46:* (1), 58, 1956. Abstr: *B. A., 30:* No. 24096, 1956.

24339. Lingappa, Y.: Tissue cultures of *Solanum tuberosum* and *Ipomoea pandurata. Amer. J. Bot., 44:* 419-423, 1957. Abstr: *Biol. Sci., 8:* No. 6151, 1958.

24340. Naqvi, S. H. Z., and H. M. Good: Ageing of conidia of *Monilinia fructicola* (Wint.) Honey. I. Germination rates and longevity. *Canad. J. Bot.,* 35: 635-645, 1957. Abstr: *Biol. Sci., 9:* No. 2153, 1958.

24341. Porter, R. H.: Longevity of loose smut *Ustilago nuda* (Jens.) Rostr. in barley seed. *Phytopathology, 45:* 637-638, 1955. Abstr: *B. A., 30:* No. 20621, 1956.

24342. Reimers, F. E.: (The correlation between growth and development in the plant's ontogenesis.) *Bot. J., U.S.S.R., 42:* 1465-1472, 1957.

24343. Richardson, S. D.: (The effect of leaf age on the rate of photosynthesis in detached leaves of tree seedlings.) *Acta bot. neerl., 6:* 445-457, 1957. Abstr: *Chem. Abstr., 52:* No. 5549, 1958.

24344. Rudajeva, A. W.: (Age changes of nucleic acids.) *Sci. Notes of Charkov St. Univ., U.S. S.R., 90:* (30), 73-78, 1957.

24345. Schwemmle, J.: (Differential ripening and ageing of seeds in different parts of the ovary of *Oenothera berteriana.*) *Planta, 49:* 168-204, 1957. Abstr: *Biol. Sci., 8:* No. 4468, 1958.

24346. Tyce, G. M.: Growth of segments of *Avena* coleoptiles in distilled water and in indolylacetic acid (IAA) during different months of the year. *Ann. Bot., Lond., 21:* 461-464, 1957. Abstr: *Biol. Sci., 8:* No. 6160, 1958.

24347. Volovik, M. P., and T. T. Kibadze: (Age changes of the electrocolloidal properties of the cell protoplasm in gastric mucosa of rabbits under different nutrition.) *Sci. Notes of Charkov St. Univ., U.S.S.R., 79:* (26), 43-53, 1957.

24348. Wilhelm, S.: Longevity of the Verticillium wilt fungus in the laboratory and field. *Phytopathology, 45:* 180-181, 1955. Abstr: *B. A., 30:* No. 2844, 1956.

24349. Wüstinger, G., H. Schönfellinger, and E. Broda: Distribution of radiocarbon in tobacco mosaic virus. *Nature, Lond., 176:* 306-307, 1955. Abstr: *B. A., 30:* No. 11571, 1956.

See also Nos. 24487, 24491, 24525.

### IV. Longevity

(case reports, drugs, heredity, marriage, occupation, and sex differences)

24350. Antoniotti, F.: Il valore dell'ereditarietà patologica in Assicurazione Vita. *Riv. Geront. Geriat., 7:* 53-73, 1958.

24351. Metrop. Life Insur. Co.: The sex ratio of mortality. *Statist. Bull. Metrop. Life Insur. Co., 39:* 6-8, May 1958.

24352. Nikitin, W. N.: (The intelligence of ways to longevity.) *Příroda, Moscow,* —: (2), 39-45, 1958.

24353. Pauling, L.: The dependence of longevity of human beings on body weight. (Abstract). *Science, 127:* 1061, 1958.

### IV-C. Longevity: *Comparative Physiology*

24354. Afifi, S. E. D., and H. Knutson: Reproductive potential, longevity and weight of house flies which survived one insecticidal treatment. *J. econ. Ent., 49:* 310-313, 1956. Abstr: *B. A., 30:* No. 32933, 1956.

24355. Allen, M. D.: Observations on honeybees attending their queen. *Brit. J. Anim. Behav., 3:* 66-69, 1955. Abstr: *B. A., 30:* No. 33567, 1956.

24356. Austin, G. H.: Effect of carbon dioxide anaesthesia on bee behaviour and expectation of life. *Bee World, 36:* 45-47, 1955. Abstr: *B. A., 30:* No. 20798, 1956.

24357. Bendell, J. F.: Age, molt and weight characteristics of blue grouse. *Condor, 57:* 354-361, 1955. Abstr: *B. A., 30:* No. 24899, 1956.

24358. Bergmann, D. E., F. E. Halleck, B. J. Mechalas, and R. I. Tenney: Factor protecting the viability of lyophilised *Brucella abortus* cells. *J. Bact., 74:* 101-105, 1957. Abstr: *Biol. Sci., 9:* No. 2987, 1958.

24359. Burnett, G. F.: Relation between age and cold resistance in tsetse flies and the value of chilling when transporting tsetse for experiments. *Proc. roy. Soc., 32:* 53-58, 1957. Abstr: *Biol. Sci., 9:* No. 4036, 1958.

24360. Danilkovich, E. M.: (The influence of penicillin on adult bees.) *Pchelovodstvo, 31:* 43-45, 1954. Abstr: *B. A., 30:* No. 15070, 1956.

24361. Davies, L.: Behaviour of young and old females of the black-fly, *Simulium ornatum* Mg. *Nature, Lond., 176:* 979-980, 1955. Abstr: *B. A., 30:* No. 17938, 1956.

24362. de Ruiter, L., and I. J. van der Horn: Variation of phototaxis with age in eyed hawk moth larva. *Nature, Lond., 179:* 1027, 1957. Abstr: *Biol. Sci., 8:* No. 4592, 1958.

24363. Eng, R. L.: A method for obtaining sage grouse age and sex ratios from wings. *J. Wildlife Mgmt., 19:* 267-272, 1955. Abstr: *B. A., 30:* No. 7073, 1956.

24364. Felin, F. E., J. MacGregor, A. E. Daugherty, and D. J. Miller: Age and length composition of the sardine catch off the Pacific Coast of the United States and Mexico in 1954-55. *Calif. Fish & Game, 41:* 285-293, 1955. Abstr: *B. A., 30:* No. 24870, 1956.

24365. Forgash, A. J.: Differences in arsenic tolerance among the sexes and various stages of the American cockroach. *J. econ. Ent., 49:* 39-43, 1956. Abstr: *B. A., 30:* No. 27255, 1956.

24366. Foskett, D. R.: Age and size of Bella Coola sockeye salmon. *Fish. Res. Bd. Canada, Pacif. progr. Repts., 102:* 16-19, 1955. Abstr: *B. A., 30:* No. 7058, 1956.

24367. Gillies, M. T.: Age groups and the biting cycle in *Anopheles gambiae;* a preliminary investigation. *Bull. ent. Res., 48:* 553-559, 1957. Abstr: *Biol. Sci., 9:* No. 4009, 1958.

24368. Hagen, B.: Eine neue methode der Alterbestimmung von Kleinsäugern. *Beitr. Zool. Bonn, 6:* 1-7, 1955. Abstr: *B. A., 30:* No. 19364, 1956.

24369. Killick, S. R.: The chronological order of Fraser River sockeye salmon during migration, spawning and death. *Bull. int. Pacif. Salmon Fish. Comm., 7:* 1-95, 1955. Abstr: *B. A., 30:* No. 24880, 1956.

24370. Koshkina, T. V.: (A method of determining the age of the rusty vole and an attempt to use it.) *Zool. Zh., 34:* 631-639, 1955. Abstr: *B. A., 30:* No. 15935, 1956.

24371. McIntyre, A. D.: The food of halibut from North Atlantic fishing grounds. *Marine Res. Serv., Scottish Home Dept., 1952:* 1-20, 1954. Abstr: *B. A., 30:* No. 28193, 1956.

24372. Marzolf, R. C.: Use of pectoral spines and vertebrae for determining age and rate of growth of the channel catfish. *J. Wildlife Mgmt., 19:* 243-249, 1955. Abstr: *B. A., 30:* No. 9786, 1956.

24373. Matheson, B. H., H. C. Grice, and M. R. E. Connell: Studies of middle ear disease in rats. I. Age of infection and infecting organisms. *Canad. J. comp. Med. (Vet. Sci.), 19:* 91-97, 1955. Abstr: *B. A., 30:* No. 2238, 1956.

24374. Miller, R. B.: The collapse and recovery of a small whitefish fishery. *Fish. res. Bd. Canada, 13:* 135-146, 1956. Abstr: *B. A., 30:* No. 24882, 1956.

24375. Oliva, O.: (Biology of the pike.) *Acta Soc. zool. Bohem., 20:* 208-223, 1956. Abstr: *Biol. Sci., 8:* No. 4544, 1958.

24376. Pflugfelder, O.: Probleme des Alterns bei Tieren. *Dtsch. med. Wschr., 83:* 345-348, 1958.

24377. Pradhan, L. B., and P. N. Kapadia: (The relation between the length of fish, and the weight and density of otolith and bone, and the rate of ossification.) *J. Univ. Bombay, 22:* 32-40, 1953. Abstr: *B. A., 30:* No. 7702, 1956.

24378. Prigozhina, E. L.: (Spontaneous tumors in rats.) *Arkh. Pat., Moskva, 18:* 109-110, 1956. Abstr: *Biol. Sci., 8:* No. 5662, 1958.

24379. Quimby, D. C., and J. E. Gaab: Mandibular dentition as an age indicator in Rocky Mountain elk. *J. Wildlife Mgmt., 21:* 435-451, 1957.

24380. Rogers, D. E., and M. A. Melly: Studies on bacteriemia. IV. Alterations in rabbit mortality associated with aging of a culture of Escherichia coli. *J. exp. Med., 107:* 561-580, 1958.

24381. Schoffman, R. J.: Age and rate of growth of the yellow bullhead in Reelfoot Lake, Tennessee. *Rep. Reelfoot Lake biol. Sta., 19:* 4-7, 1955. Also *in: J. Tenn. Acad. Sci., 30:* 4-7, 1955. Abstr: *B. A., 30:* No. 408, 1956.

24382. Schoffman, R. J.: Age and rate of growth of the yellow bass in Reelfoot Lake, Tennessee for 1939 and 1955. *Rep. Reelfoot Lake biol. Sta., 20:* 20-25, 1956. Also *in: J. Tenn. Acad. Sci., 31:* 20-25, 1956. Abstr: *B. A., 30:* No. 33711, 1956.

24383. Schofield, R. D.: Analysis of muskrat age determination methods and their application in Michigan. *J. Wildlife Mgmt., 19:* 463-466, 1955. Abstr: *B. A., 30:* No. 15943, 1956.

24384. Sinkovics, J.: Occurrence and filterability of protoplast-like elements in aged bacterial cultures. *Nature, Lond., 181:* 566-567, 1958.

24385. Tester, A. L.: Estimation of recruitment and natural mortality rate from age-composition and catch data in British Columbia herring populations. *Fish. res. Bd. Canada, 12:* 649-681, 1955. Abstr: *B. A., 30:* No. 28207, 1956.

24386. Tsygankov, D. S.: (A method of determining the age and length of life of the muskrat (*Fiber zibethicus* L.).) *Zool. Zh., 34:* 640-651, 1955. Abstr: *B. A., 30:* No. 15945, 1956.

24387. Uhlig, H. G.: The determination of age of nestling and sub-adult gray squirrels in West Virginia. *J. Wildlife Mgmt., 19:* 479-483, 1955. Abstr: *B. A., 30:* No. 15946, 1956.

24388. Williams, V. R.: Aspartase activity of cell free extracts prepared from aged cell suspensions of *Bacterium cadaveris*. *J. Bact., 74:* 410-411, 1957. Abstr: *Biol. Sci., 10:* No. 719, 1958.

24389. Wolbarsht, M. L.: Water taste in *Phormia*. *Science, 125:* 1248, 1957. Abstr: *Biol. Sci., 8:* No. 6299, 1958.

24390. Yamamura, Y.: (Relation between the age of sharks and the group accumulative ratio of vitamin A.) *Bull. Jap. Soc. sci. Fish., 19:* 530-532, 1953. Abstr: *B. A., 30:* No. 417, 1956.

See also Nos. 24329, 24347, 24417, 24421, 24425, 24428, 24430, 24432, 24435, 24440, 24447, 24449, 24464, 24468, 24473, 24479, 24488, 24499, 24500, 24507, 24508, 24510, 24512, 24519, 24523, 24524, 24532, 24533, 24548, 24551, 24560, 24561, 24562, 24564, 24566, 24569, 24570, 24571, 24574, 24578, 24580, 24583, 24584, 24588, 24594, 24598, 24613, 24633, 24636, 24643.

### IV-H. Longevity: *Mortality Rates*

24391. Boretti, L.: La legge di distribuzione delle più alte età. 1. La verifica della legge di Fisher Gumbel a Genova nel periodo 1880-1954. *Longevità, 6:* 9-12, 1958.

24392. Boretti, L.: La legge di distribuzione delle più alte età. 2. *Longevità, 6:* 53-56, 1958.

24393. Dall'Acqua, G. F., and G. Trompeo: La difterite in Torino nel decennio 1945-1954. Rilievi e considerazioni. *G. Batt. Immun., 48:* 164-173, 1955. Abstr: *B. A., 30:* No. 17084, 1956.

24394. Lotte, A., M. Moine, A. Rouillon, and L. Maujol: Évolution de la mortalité par tuberculose en France suivant l'âge et le sexe. *Bull. Inst. nat. Hyg., 10:* 271-328, 1955. Abstr: *B. A., 30:* No. 30829, 1956.

24395. Metcalf, D.: The aetiological significance of differing patterns in the age incidence of cancer mortality. *Med. J. Aust.,* 1, *42:* 874-878, 1955. Abstr: *B. A., 30:* No. 13844, 1956.

24396. Metrop. Life Insur. Co.: Longevity changes little in recent years. *Statist. Bull. Metrop. Life Insur. Co., 39:* 1-3, June 1958.

24397. Metrop. Life Insur. Co.: Trends in cancer mortality. *Statist. Bull. Metrop. Life Insur. Co., 39:* 3-6, June 1958.

24398. Reyes, A. C., and C. Lamanna: Snakebite mortality in the Philippines. *Philipp. J. Sci., 84:* 189-194, 1955. Abstr: *B. A., 30:* No. 30835, 1956.

24399. Sigler, L. H.: The mortality from arteriosclerotic and hypertensive heart diseases in the United States. I. Possible relation to distribution of population and economic status. *Amer. J. Cardiol., 1:* 176-180, 1958.

24400. U. S. Department of Health, Education and Welfare. Public Health Service. National Office of Vital Statistics: Mortality from each cause; United States, 1954-56. *Vit. Statist., Spec. Rep., Nat. Summaries, 48:* (4), 65-101, 1958.

24401. U. S. Department of Health, Education and Welfare. Public Health Service. National Office of Vital Statistics: Mortality from each cause by color and sex; United States, 1956. *Vit. Statist., Spec. Rep., Nat. Summaries, 48:* (5), 107-141, 1958.

24402. U. S. Department of Health, Education and Welfare. Public Health Service. National Office of Vital Statistics: Abridged life tables; United States, 1956. *Vit. Statist., Spec. Rep., Nat. Summaries, 48:* (6), 144-154, 1958.

24403. Walter, W. A., and A. G. Gilliam: Leukaemia mortality. Geographic distribution in United States for 1949-1951. *J. nat. Cancer Inst., 17:* 475-480, 1956. Abstr: *Biol. Sci., 8:* No. 3623, 1958.

24404. Anonymous: Incidence du sexe et de l'âge sur la morbidité et la mortalité par maladies infectieuses en 1953. *Bull. Inst. nat. Hyg., 9:* 831-849, 1954. Abstr: *B. A., 30:* No. 2301, 1956. See also No. 24559.

### IV-I. Longevity: *National Groups*

24405. Macháček, E.: (Registration of mortality causes and its statistical significance.) *Českoslov. zdravot., 5:* 726-727, 1957.

24406. Matsuoka, S., S. Nishikawa, K. Shimizu, T. Hotta, Y. Ômura, K. Ogawa, and H. Yoshitoshi: *(Surveys on the Old People's Home in Japan. IV. Special causes of death in the institutioned.)* The Authors, Tokyo Univ., 1958, 8 pp.

24407. Metrop. Life Insur. Co.: International gains in longevity. *Statist. Bull. Metrop. Life Insur. Co., 39:* 1-3, April 1958.

24408. Moraes, N. L. De A.: A longevidade nas cidades de Alagoa Grande e Esperança (Estado da Paraíba), no período 1951-1953. *Rev. Serv. espec. Saúde Públ.,* 7: 393-408, 1955. Abstr: *B. A., 30:* No. 35260, 1956.

24409. Moraes, N. L. De A.: A longevidade nas cidades de Ilhéus (inclusive Pontal) e Itabuna (Estado da Bahia), no período 1951-1953. *Rev. Serv. espec. Saúde Públ.,* 7: 409-424, 1955. Abstr: *B. A., 30:* No. 35261, 1956.

24410. Tamura, E., and N. Matsuno: (A statistical and actual survey on the distribution of longevity in Japan. 3.) *Jap. J. Nutrit., 11:* 45-49, 1953. Abstr: *B. A., 30:* No. 23555, 1956.

24411. Tamura, E., A. Nishihara, F. Yokota, N. Matsuno, and S. Isobe: (A statistical and actual survey on the distribution of longevity in Japan. 2.) *Jap. J. Nutrit., 11:* 41-44, 1953. Abstr: *B. A., 30:* No. 23554, 1956.

24412. Ugalde, A. A., and M. S. B. Becherelle: Tablas de vida para la republica Mexicana en 1950. *Rev. Inst. Salub. Enferm. trop., 15:* 39-50, 1955. Abstr: *B. A., 30:* No. 14375, 1956.

See also No. 24759.

### V. Metabolism

24413. Alexander, N. M.: Catalase inhibition by normal and neoplastic tissue extracts. *J. biol. Chem., 227:* 975-985, 1957. Abstr: *Biol. Sci., 9:* No. 2601, 1958.

24414. Blau, M., H. Spencer, J. Swernov, J. Greenberg, and D. Lazlo: Effect of intake level on the utilization and intestinal excretion of calcium in man. *J. Nutrit., 61:* 507-521, 1957. Abstr: *Biol. Sci., 8:* No. 2830, 1958.

24415. Christie, R. W., and L. K. Dahl: Dissimilarity in oxygen consumption between the thoracic and abdominal aorta in rats. *J. exp. Med., 106:* 357-364, 1957. Abstr: *Biol. Sci., 10:* No. 1237, 1958.

24416. Ernster, L., H. Löw, K. Nordenbrand, and B. Ernster: A component promoting oxidative phosphorylation, released from mitochondria during aging. *Exp. cell Res., 9:* 348-349, 1955. Abstr: *B. A., 30:* No. 18535, 1956.

24417. Everitt, A. V.: The urinary excretion of protein, non-protein nitrogen, creatinine and uric acid in ageing male rats. *Gerontologia, 2:* 33-46, 1958.

24418. Hrůza, Z., and O. Poupa: (Adaptation of metabolism. V. A method of experimental traumatisation in the Noble-Collip drum.) *Physiol. Bohemoslov., 6:* 179-187, 1957. Abstr: *Biol. Sci., 9:* No. 1558, 1958.

24419. Klotzbücher, E.: Über die blutzuckersenkende Wirkung des peroralen Antidiabetikums Artosin (D 860) bei Stoffwechselgesunden verschiedenen Lebensalters. *Z. Altersforsch., 11:* 162-167, 1958.

24420. Maier, B., and H. Haimovici: Metabolism of arterial tissues. Oxidative capacity of intact arterial tissue. *Proc. Soc. exp. Biol., N. Y., 95:* 425-429, 1957. Abstr: *Biol. Sci., 9:* No. 1787, 1958.

24421. Mallucci, L.: Studio comparativo di alcune attività enzimatiche nel topo neonato e nell'adulto. II. Attività adenilpirofosfatasica. *Boll. Soc. ital. Biol. sper.,* 33: 1081-1082, 1957.

24422. Miller, L. A., A. E. Bagot, and D. M. Greenberg: Metabolic comparison of particulate components of rat liver cytoplasm. *Proc. Soc. exp. Biol., N. Y., 89:* 299-303, 1955. Abstr: *B. A., 30:* No. 3996, 1956.

24423. Petrunkina, A. M., and A. M. Libov (Editors): *(The biochemistry of aging.)* Medical Publ. House, Leningrad, 1956, 88 pp.

24424. Robertson, J. D.: Basal metabolic rate in old men and related data. *Lancet, 1:* 296-297, 1958.

24425. Shimizu, N., and M. Okada: Histochemical distribution of phosphorylase in rodent brain from newborn to adults. *J. Histochem. Cytochem., 5:* 459-471, 1957.

24426. Squibb, R. L., A. Aguirre, J. E. Braham, N. S. Scrimshaw, and E. Bridgforth: Effects of age, sex and feeding regimen on fat digestibility in individual rats as determined by a rapid extraction procedure. *J. Nutrit., 64:* 625-634, 1958.

24427. Tonna, E. A.: Enzyme changes in the aging periosteum. *Nature, Lond., 181:* 486, 1958.

24428. Wanner, R. L.: Calcium metabolism in dogs, with respect to age and exercise. *Disserta. Abstr., Cornell Univ., 15:* 196-197, 1955. Abstr: *B. A., 30:* No. 6848, 1956.

See also Nos. 24388, 24430, 24432, 24443, 24488, 24493, 24571, 24589, 24590.

## VI. Nutrition

24429. Babcock, M. J., H. N. Church, and L. O. Gates: Nutritional status of industrial workers. II. Effects of education, age, income, and ethnic groups. *Milbank mem. Fd. quart. Bull.,* 33: 137-151, 1955. Abstr: *B. A., 30:* No. 25299, 1956.

24430. Draper, H. H., and C. Lowe: Physiologic aspects of aging. II. Radiocyanocobalamin absorption and protein digestion by the rat. *J. Geront., 13:* 252-254, 1958.

24431. Ellenbogen, L., B. F. Chow, and W. L. Williams: Effect of intrinsic factor on absorption of vitamin $B_{12}$ in healthy individuals. *Amer. J. clin. Nutrit., 6:* 26-29, 1958. Abstr: *Chem. Abstr., 52:* No. 7456, 1958.

24432. Everitt, A. V.: The change in food and water consumption and in faeces and urine production in ageing male rats. *Gerontologia, 2:* 21-32, 1958.

24433. Goodman, J. I.: Nutrition, life tenure, and the degenerative diseases. *Geriatrics, 13:* 359-366, 1958.

24434. Lane, P. W., and M. M. Dickie: The effect of restricted food intake on the life span of genetically obese mice. *J. Nutrit., 64:* 549-554, 1958.

24435. Lowe, J. S., R. A. Morton, N. F. Cunningham, and J. Vernon: Vitamin A deficiency in domestic fowl. *Biochem. J., 67:* 215-223, 1957. Abstr: *Biol. Sci., 9:* No. 443, 1958.

24436. Pegel, L. A., Jr.: Iron therapy for aged patients. *J. Amer. geriat. Soc., 6:* 621-622, 1958.

24437. Rock, J.: Good food is good medicine for the aged. *Mod. Hosp., 90:* (3), 108, 1958.

24438. Terroine, T.: (Protection by ascorbic acid during vitamin $B_1$ starvation.) *C. R. Acad. Sci., Paris, 245:* 567-570, 1957. Abstr: *Biol. Sci., 9:* No. 473, 1958.

See also Nos. 24330, 24426, 24457, 24465, 24474, 24511, 24519, 24677, 24681.

## VII. Parental Age

24439. Gregory, I.: An analysis of familial data on psychiatric patients; parental age, family size, birth order, and ordinal position. *Brit. J. prev. soc. Med., 12:* 42-59, 1958.

24440. Strong, L. C., and C. A. Fuller: Maternal age at time of first litters in mice. *J. Geront., 13:* 236-240, 1958.

24441. Torre, M., and S. Cibelli: Influenza dell'età materna nella comparsa del mongolismo. *Boll. Soc. ital. Biol. sper.,* 33: 1142-1145, 1957.

## X. Theories

24442. Anderson, J. E.: (A developmental model for aging.) *Vita Humana, 1:* 5-18, 1958.

24443. Andrew, W.: Is there a "cellular basis" for aging? *J. nat. med. Ass., N. Y., 50:* 155-157, 1958.

24444. Bürger, M.: Biomorfosi o Gerontologia? *Gior. Geront., 6:* 147-156, 1958.

24445. Rigas, D. A.: Kinetics of isotope incorporation into the desoxyribonucleic acid (DNA) of tissues; life span and generation time cells. *Bull. math. Biophysics, 20:* 33-70, 1958.

24446. Yockey, H. P. (Editor): *Symposium on information theory in biology.* Pergamon Press, New York, 1958.

## ORGAN SYSTEMS

### I. Blood

24447. Altschul, R., D. J. MacFadyen, and W. F. Whitehead: Prenatal hypo-oxia on spontaneous leukaemia in mice. *Cancer Res., 17:* 222-226, 1957. Abstr: *Biol. Sci., 9:* No. 3189, 1958.

24448. Callender, S. T., and M. A. Denbotough: Family study of pernicious anaemia. *Brit. J. Haemat., 3:* 88-106, 1957. Abstr: *Biol. Sci., 8:* No. 3620, 1958.

24449. Everitt, A. V., and C. Webb: The blood picture of the aging male rat. *J. Geront., 13:* 255-260, 1958.

24450. Furuhata, T., and M. Eguchi: (The change of the agglutinability of normal human blood cells with age.) *Proc. Jap. Acad., 31:* 555-557, 1955.

24451. Jiménez de Asua, F.: Influencia del factor subracial, la edad y el sexo en la frecuencias de las leucemias. *Medicina, 17:* 92-93, 1957.

24452. Nadel, E. M.: Transplantation of leukaemia from inbred to non-inbred guinea-pigs. *J. nat. Cancer Inst., 19:* 351-359, 1957. Abstr: *Biol. Sci., 10:* No. 901, 1958.

24453. Perkowska, E.: (Relationship between the age of the neutrophil and the susceptibility of its nucleus to hydrolysis with urine dialysate.) *Acta haemat., Basel, 17:* 247-249, 1957. Abstr: *Biol. Sci., 8:* No. 4008, 1958.

See also Nos. 24505, 24563, 24655.

#### I-A. Blood: *Chemistry*

24454. Bloomberg, B. M., F. Lazarus, I. Mrost, and R. Schneider: Serum lipids in South African Bantu and white subjects. *Circulation, N. Y., 17:* 1021-1028, 1958.

24455. Bobochodzhaev, M. Ch., and J. A. Makarevich: (The content of serum protein fractions in healthy men of different ages and with atherosclerosis.) *Publ. Hlth. Tajikistan, U.S.S.R.,* —: (3), 37-40, 1957.

24456. DeLalla, L., L. Levine, and R. K. Brown: Immunological studies of human high density lipoproteins. *J. exp. Med., 106:* 261-271, 1957. Abstr: *Biol. Sci., 10:* No. 645, 1958.

24457. Engelberg, H.: Effect of safflower oil on serum cholesterol and lipoproteins in patients on a low-fat diet. *Geriatrics, 13:* 512-516, 1958.

24458. Furman, R. H., R. P. Howard, M. R. Shetlar, E. C. Keaty, and R. Imagawa: A comparison of the serum lipids lipoproteins, glycoproteins, urinary 17-ketosteroids, and gonadotropins in eunuchs and control male subjects. *Circulation, N. Y., 17:* 1076-1085, 1958.

24459. Hamilton, J. B., L. D. Bunch, G. E. Mestler, and R. Imagawa: Effect of orchiectomy upon chemical constituents of blood in young mature males with special reference to sustained increase in the level of serum inorganic phosphorus. *J. clin. Endocrinol., 16:* 301-321, 1956. Abstr: *B. A., 30:* No. 28377, 1956.

24460. Payne, I. R.: Effect of altitude and diet on hematopoiesis and serum cholesterol. *J. Nutrit., 64:* 433-446, 1958.

24461. Schwartz, C. J., and H. R. Gilmore: Effect of atherosclerosis and age upon the serum mucoprotein and hexosamine levels in man. *Circulation, N. Y., 18:* 191-195, 1958.

24462. Walter, H., and F. Haurowitz: Turnover of young and old serum proteins. *Science, 128:* 140-141, 1958.

24463. Zanussi, C., P. Taschini, and G. Romagnoli: (Properdin level in the blood of normal persons.) *Atti Soc. Lombarda Sci. Med. Biol., 12:* 149-151, 1957. Abstr: *Chem. Abstr., 52:* No. 4782, 1958.

See also Nos. 24419, 24431, 24436, 24449, 24460, 24474.

#### I-B. Blood: *Coagulation*

24464. Berman, H. J., G. P. Fulton, B. R. Lutz, and D. L. Pierce: Susceptibility to thrombosis in normal young, aging, cortisone-treated, heparinized and x-irradiated hamsters as tested by topical application of thrombin. *Blood, 10:* 831-840, 1955. Abstr: *B. A., 30:* No. 16265, 1956.

24465. Brown, R. W. B., and T. H. Howell: Beriberi thrombocytopenic purpura in a man of 81; an example of multiple pathology. *Geriatrics, 13:* 545-546, 1958.

### II. Blood Forming and Destroying Organs

24466. Graf, K., and E. Stein: (Continuous registration calorimeter sonde of blood flows in human sternal marrow.) *Z. ges. exp. Med., 129:* 1-14, 1957. Abstr: *Biol. Sci., 9:* No. 1816, 1958.

### III. Cardiovascular System

(blood vessels, blood pressure, hypertension, blood volume, veins, and arteriosclerosis)

24467. Beem, J. R., and J. H. Moyer: Antihypertensive therapy for the elderly patient. *Geriatrics, 13:* 378-390, 1958.

24468. Friedman, S. M., A. G. Middleton, and C. L. Friedman: Diminished blood pressure lability in ageing rats. *Gerontologia, 2:* 47-54, 1958.

24469. Karnbaum, S.: (Hypertension and its effects on the size, elasticity, and weight of the heart and arteries.) *Virchows Arch., 330:* 200-211, 1957. Abstr: *Biol. Sci., 8:* No. 5521, 1958.

24470. Master, A. M., R. P. Lasser, and H. L. Jaffe: Blood pressure in white people over 65 years of age. *Ann. intern. Med., 48:* 284-299, 1958.

24471. Meyer, W. W., and P. Schollmeyer: Die Volumendehnbarkeit und die Druck-Umfang-Beziehungen des Lungenschlagader-Windkessels in Abhängigkeit vom Alter und pulmonalem Hochdruck. *Klin. Wschr., 35:* 1070-1076, 1957.

24472. Oehme, J., and R. Haberland: Die Kapillarresistenz bei Kindern und älteren Erwachsenen. *Ärztl. Wschr., 12:* 673-676, 1957.

24473. Ratcliffe, H. L., and M. T. I. Cronin: Changing frequency of arteriosclerosis in mammals and birds at the Philadelphia Zoological Garden; review of autopsy records. *Circulation, N. Y., 18:* 41-52, 1958.

24474. Stamler, J.: Epidemiology as an investigative method for the study of human atherosclerosis. *J. nat. med. Ass., N. Y., 50:* 161-200, 1958.

24475. Tejada, C., I. Gore, J. P. Strong, and H. C. McGill, Jr.: Comparative severity of atherosclerosis in Costa Rica, Guatemala, and New Orleans. *Circulation, N. Y., 18:* 92-97, 1958.

24476. Yamakawa, K., S. Nishikawa, H. Kawamura, K. Kiyono, H. Nakamura, S. Sezoko, and S. Nagi: *(Postural blood pressure reflex (tilting test) in the aged.)* The Authors, Tokyo Univ., 1958, 5 pp.

See also Nos. 24415, 24420, 24466, 24536, 24550, 24678.

III-G. Cardiovascular System: *Heart*

(heart, anatomy and physiology, heart disease, coronary artery disease, and myocardial disease)

24477. Actis-Dato, A., and A. Tarquini: Su un caso di comunicazione interatriale in età avanzata trattato chirurgicamente. *Acta Geront., 8:* 24-36, 1958.

24478. Azzolini, G., and F. Barboni: Cuore senile. Spunti morfologici e fisiopatologici sulle arterie coronarie intramurali nell'età avanzata. *Gior. Geront., 6:* 75-102, 1958.

24479. Everitt, A. V.: Heart position in the ageing male rat in relation to lung disease. *Gerontologia, 2:* 73-80, 1958.

24480. Friedberg, R., and B. Sjoestroem: (Quinidine treatment of auricular fibrillation.) *Acta med. scand., 155:* 293-305, 1956. Abstr: *Biol. Sci., 8:* No. 5816, 1958.

24481. Kelly, J. J., Jr., and H. A. Lyons: Atrial septal defect in the aged. *Ann. intern. Med., 48:* 267-283, 1958.

24482. Mezzasalma, G., and M. Morpurgo: L'elettrocardiogramma senile: studio statistico e considerazioni anatomo-cliniche su 4401 tracciati di ultrasettantenni; infarto miocardico ed insufficienza coronarica. *Folia cardiol., 16:* 561-574, 1957.

24483. Okinaka, S.: (The statistical review of cases with clinically diagnosed myocardial infarction and with anginal pains in several districts in Japan.) *Jap. circ. J., 21:* 8 pp., 1957.

24484. Okinaka, S.: (The statistical review of pathologically proved cases of myocardial infarction, sclerosis of A. coronaria, aorta, A. basilaris and A. renalis.) *Jap. circ. J., 21:* 10 pp., 1957.

24485. Stuckey, D.: Ischaemic heart disease; a statistical study. *Med. J. Aust., 1:* 169-171, 1955. Abstr: *B. A., 30:* No. 4440, 1956.

24486. Taran, L. M., and N. Szilagyi: Electrocardiographic changes with advancing age. *Geriatrics, 13:* 352-358, 1958.

See also Nos. 24335, 24469, 24575.

IV. Connective Tissue and Cartilage

24487. Barbieri, E.: L'esocinasi della cartilagine metafisaria in relazione all'età. *Boll. Soc. ital. Biol. sper., 33:* 1051-1052, 1957.

24488. Barbieri, E.: Attività citrogenasica della cartilagine di coniugazione in conigli giovani di varia età. *Boll. Soc. ital. Biol. sper., 33:* 1052-1054, 1957.

24489. Boucek, R. J., N. L. Noble, T. K.-Y. Kao, H. R. Elden, and J. F. Woessner, Jr.: Connective tissue changes which may be related to aging and atherosclerosis. *Minn. Med., 41:* 154-156, 1958.

24490. Kohn, R. R., and E. Rollerson: Relationship of age to swelling properties of human diaphragm tendon in acid and alkaline solutions. *J. Geront., 13:* 241-247, 1958.

24491. Kuhn, R., and H. J. Leppelmann: (Hexosamine content of the cartilage as a function of age.) *Planck Inst. Med. Forsch., 607:* 202-206, 1957. Abstr: *Chem. Abstr., 52:* No. 6530, 1958.

24492. Ruygikh, G. N.: (Age changes in the cellular element of the subcutaneous connective tissue in certain vertebrates.) *Arch. Anat. Hist. Embriol., U.S.S.R., 34:* (4), 98-99, 1957.

24493. Verzár, F., and V. Freydberg-Lucas: Calcium$^{45}$ uptake and turnover of tendon fibres as influenced by thermic contraction and age. *Gerontologia, 2:* 11-21, 1958.

24494. Verzár, F., and K. Huber: Thermic-contraction of single tendon fibres from animals of different age after treatment with formaldehyde, urethane, glycerol, acetic acid and other substances. *Gerontologia, 2:* 81-103, 1958.

24495. Verzár, F., and K. Huber: The affinity of collagen fibres for radio-isotopes Ca$^{45}$, Na$^{24}$, K$^{42}$ and I$^{131}$ during thermic contraction. *Gerontologia, 2:* 113-121, 1958.

See also Nos. 24461, 24623, 24633, 24638.

V. Endocrine System

(includes sex glands and climacteric)

24496. Boyden, A. M.: Exploration of duct of Wirsung and pancreatolithotomy; their place in the management of chronic pancreatitis. *Portland clin. Bull., 11:* 79-92, 1958.

24497. Ficarra, B. J.: Phantom goiter; report of 3 cases in women aged 68-70. *J. Amer. geriat. Soc., 6:* 532-533, 1958.

24498. Goldzieher, J. W.: New technics in the diagnosis of hyperparathyroidism. *Geriatrics, 13:* 483-488, 1958.

24499. Hollandbeck, R.: Age trends in gonadotrophic and thyrotrophic hormones in swine. *Disserta. Abstr., Univ. Ill., 15:* 657, 1955. Abstr: *B. A., 30:* No. 12160, 1956.

24500. Hollandbeck, R., B. Baker, Jr., H. W. Norton, and A. V. Nalbandov: Gonadotrophic hormone content of swine pituitary glands in relation to age. *J. Anim. Sci., 15:* 418-427, 1956. Abstr: *B. A., 30:* No. 28661, 1956.

24501. Kuzmina-Prigradova, A. V.: (Age characteristics of blood supply to the suprarenal glands.) *Russk. Arkh. Anat., 31:* 47-54, 1954. Abstr: *B. A., 30:* No. 34736, 1956.

24502. Lynn, W. G., and J. N. Dent: Phenylthiourea treatment and the binding of radioactive iodine in the tadpole. *Biol. Bull. Wood's Hole, 113:* 160-169, 1957. Abstr: *Biol. Sci., 9:* No. 2002, 1958.

24503. Magendie, J., J. Magimel, —. Honton, and —. Chassaigne: Enquête statistique sur l'étiologie des méno-métrorragies en particulier à la période climatérique. *C. R. Soc. franç. gyn., Paris, 27:* 344-355, 1957.

24504. Masuda, M., and T. H. Holmes: Ketosteroids in urine of normal children using alumina chromatographic fractionation. *Pediatrics, 19:* 424-430, 1957. Abstr: *Biol. Sci., 9:* No. 172, 1958.

24505. Matsuoka, S., S. Nishikawa, I. Wakisaka, K. Shimada, C. Machida, N. Yano, and S. Kotôda: *(Studies on the eosinophile leucocyte. VIII. Counts of eosinophiles and Thorn's test in aged.)* The Authors, Tokyo Univ., 1958, 4 pp.

24506. Misurale, F.: Sulla terapia della sindrome climaterica. *Quad. clin. ostet., 12:* 719-724, 1957.

24507. Mosca, L.: Anterior pituitary and morphology of pancreatic islets in the rat. *Quart. J. exp. Physiol., 42:* 267-278, 1957. Abstr: *Biol. Sci., 9:* No. 1961, 1958.

24508. Munford, R. E.: Effect of age, sex, gonadectomy, sodium chloride intake, and treatment with cortisol acetate upon the lifespan of adrenalectomized mice of an albino strain. *J. Endocr., 16:* 57-71, 1957. Abstr: *Chem. Abstr., 52:* No. 6607, 1958.

24509. Østergaard, E.: (Symptoms and treatment of climacteric and premenstrual tension.) *Mskr. prakt. laegegern, 35:* 421-428, 1957.

24510. Quay, W. B.: Cytochemistry of pineal lipids in rat and man. *J. Histochem. Cytochem., 5:* 145-153, 1957. Abstr: *Biol. Sci., 8:* No. 4637, 1958.

24511. Rudajeva, A. W.: (The age histophysiological changes of the endocrine glands under different nutrition.) *Sci. Notes of Charkov St. Univ., U.S.S.R., 79:* (26), 23-42, 1957.

24512. Stevens, L. C., and K. P. Hummel: Spontaneous congenital testicular teratomas in strain 129 mice. *J. nat. Cancer Inst., 18:* 719-747, 1957. Abstr: *Biol. Sci., 8:* No. 5643, 1958.

24513. Vermeulen, A., and I. Leusen: Influence de la réserpine sur l'excrétion des gonadotrophines urinaires chez la femme ménopausée ou castrée. *Ann. Endocrin., Paris, 18:* 803-807, 1957.

See also Nos. 24459, 24667, 24740.

### VI. Gastro-Intestinal Tract

24514. Bennett, H. D.: Hepatitis in the geriatric patient. *Geriatrics, 13:* 345-351, 1958.

24515. Case, T. C.: Prolapse of the rectum. *J. Amer. geriat. Soc., 6:* 526-531, 1958.

24516. Coodley, E.: Management of geriatric constipation. *Clin. Med., 4:* 1509, 1957. Abstr: *J. Amer. geriat. Soc., 6:* 560, 1958.

24517. Dalgaard, J. B.: (Oesophago-gastro-duodenal ulcerations encountered at autopsy. I. Ulcer and brain.) *Acta path. microbiol. scand., 4:* 1-18, 1957. Abstr: *Biol. Sci., 9:* No. 1125, 1958.

24518. Girard, M., M. Plauchu, J. Fayolle, and G. Masson: La cirrhose du foie après 65 ans; étude critique à propos de 103 observations. *Lyon méd., 89:* 463-471, 1957.

24519. Green, G., A. A. Horner, J. S. Lowe, and R. A. Morton: Cholesterol and liver vitamin A in male and female rats. *Biochem. J., 67:* 235-238, 1957. Abstr: *Biol. Sci., 9:* No. 446, 1958.

24520. Harrower, H. W., D. L. Brook, and P. Cooper: Gastric pepsin and uropepsin in patients with duodenal ulcer. *Ann. Surg., 144:* 816-822, 1956. Abstr: *Biol. Sci., 10:* No. 478, 1958.

24521. Howell, T. H.: Unexpected ulcers. *Practitioner, 180:* 343, 1958.

24522. Hungerland, H., J. Quenzlein, and H. Werner: (The sodium and potassium contents of the saliva of normal infants, children, and adults.) *Z. Kinderheilk., 80:* 178-189, 1957. Abstr: *Chem. Abstr., 52:* No. 4784, 1958.

24523. Krook, L.: (On gastrointestinal carcinoma in the dog.) *Acta path. microbiol. scand., 38:* 43-57, 1956. Abstr: *B. A., 30:* No. 34701, 1956.

24524. Lengemann, F. W., and N. N. Allen: The development of rumen function in the dairy calf. I. Some characteristics of the rumen contents of cattle of various ages. *J. Dairy Sci., 38:* 651-656, 1955. Abstr: *B. A., 30:* No. 10122, 1956.

24525. Naora, H.: Microspectrophotometry of cell nuclei stained with the Feulgen reaction. IV. Formation of tetraploid nuclei in rat liver cells during postnatal growth. *J. Biophys. biochem. Cytol., 3:* 949-975, 1957. Abstr: *Chem. Abstr., 52:* No. 5596, 1958.

24526. Pierre-Bourgeois, —., and J. Rogé: Les ulcères gastriques géants des sujets âgés. *Bull. Acad. nat. Méd., Paris, 142:* 21-25, 1958.

24527. Reeves, M. M., D. Meredith, and F. J. Lewis: Appendicitis in the older patient. *Surg., Gynec. Obstet., 106:* 610-612, 1958. Abstr: *Geriatrics, 13:* 462, 1958.

24528. Roth, H. P., S. B. Fein, and M. F. Sturman: Mechanisms responsible for the urge to defaecate. *Gastroenterology, 32:* 717-726, 1957. Abstr: *Biol. Sci., 9:* No. 3708, 1958.

24529. Saubier, E. C., and H. Fernoux: À propos de deux cas d'occlusions du grêle par diverticule de Meckel; l'une par noeud l'autre par bride chez deux femmes âgées. *Lyon chir., 53:* 922-924, 1957.

24530. Shiner, M., and I. Doniach: Study of x-ray negative dyspepsia with reference to histological changes in the gastric mucosa. *Gastroenterology, 32:* 313-324, 1957. Abstr: *Biol. Sci., 8:* No. 5543, 1958.

24531. Thompson, C. M., and J. M. Gambescia: Common digestive problems in the older patient. *Geriatrics, 13:* 402-416, 1958.

24532. Willett, N. P., S. Rosen, H. J. Stafseth, H. R. Hunt, and C. A. Hoppert: Comparison of salivary protease activity in Hunt-Hoppert caries-resistant and caries-susceptible rats. *J. dent. Res., 36:* 223-229, 1957. Abstr: *Biol. Sci., 8:* No. 2626, 1958.

See also Nos. 24347, 24379, 24422, 24545, 24546.

### VII. Kidney

24533. Bachra, B. N., and B. S. J. Wöstmann: (The clearance of phosphate and inulin in the white rat.) *Arch. int. Physiol. Biochim., 63:* 104-113, 1955. Abstr: *Chem. Abstr., 52:* No. 4771, 1958.

24534. Leichsenring, F.: (Ostial lumen of the renal arteries in relation to aortic lumen in healthy and atherosclerotic vessels.) *Z. KreislForsch., 46:* 188-196, 1957. Abstr: *Biol. Sci., 8:* No. 3594, 1958.

See also No. 24417.

### IX. Muscular System

24535. Bélanger, C., and C. Plamondon: À propos de myasthénie grave aux âges extrêmes de la vie; deux cas. *Laval méd., 24:* 335-344, 1957.

24536. Katinas, G. S.: (The arteries of the muscles of the animal's and men's shoulder in different age.) *Repts. Pedagogical Acad. Sci., U.S.S.R.,* —: (84), 133-160, 1957.

24537. Schoen, L., M. Stosiek, and O. Fleischmann: (Composition of beef raw material with respect to muscles, grade, age, feeding and breed.) *Fleischwirtschaft, 10:* 89-93, 1958. Abstr: *Chem. Abstr., 52:* No. 7559, 1958.

### X. Nervous System
(neurology)

24538. Chafetz, M. E.: The role of psychiatry in the treatment of Parkinson's disease. *Geriatrics, 13:* 435-440, 1958.

24539. Derjabina, G. I.: (Some changes of the brain's chemistry with age.) *Sci. Notes of Gorky Med. Inst., U.S.S.R.,* —: (1), 45-54, 1957.

24540. Hallervorden, J.: Das normale und pathologische Altern des Gehirns. *Nervenarzt, 28:* 433-445, 1957.

24541. Kapustina, E. V.: (Age correlations of arterial and venous networks in the pia mater of the big hemispheres of the brain in postnatal life.) *Pediatria, U.S.S.R.,* —: (2), 75-82, 1958. (English summary).

24542. Kooi, K. A., and M. H. Thomas: Electronic analysis of cerebral responses to photic stimulation in patients with brain damage. *Electenceph. clin. Neurophysiol., 10:* 417-424, 1958.

24543. Magladery, J. W., R. D. Teasdall, and A. H. Norris: Effect of aging on plantar flexor and superficial abdominal reflexes in man; a clinical and electromyographic study. *J. Geront., 13:* 282-288, 1958.

24544. Northfield, D. W. C.: Rathke-Pouch tumours. *Brain, 80:* 293-312, 1957. Abstr: *Biol. Sci., 10:* No. 839, 1958.

24545. Panchenko, L. F.: (The incorporation of $S^{35}$ methionine in the proteins of the central nervous system and liver by animals at different age.) *Moscow med. Inst., 6:* 41-48, 1957.

24546. Panchenko, L. F.: (Age pecularities of the protein turnover in various levels of the central nervous system and in the liver.) *Sechenov J. Physiol., U.S.S.R., 44:* 243-248, 1958.

24547. Popa, A. V.: (On nerves and receptors of periosteum of lower jaw.) *Trud. Kishiney med. Inst., 4:* 31-36, 1955. Abstr: *Biol. Sci., 9:* No. 2295, 1958.

24548. Wayner, M. J., Jr., and R. Emmers: Spinal synaptic delay in young and aged rats. *Amer. J. Physiol., 194:* 403-405, 1958.

24549. Wieriepaeva, I. S.: (Age changes of the free and colloid bound water in different sections of the brain.) *Sci. Notes of Gorky Med. Inst., U.S.S.R.,* —: (1), 33-35, 1957.

24550. Winter, M. D., Jr., G. P. Sayre, C. H. Millikan, and N. W. Barker: Relationship of degree of atherosclerosis of internal carotid system in the brain of women to age and coronary atherosclerosis. *Circulation, N. Y., 18:* 7-18, 1958.

### XI. Reactions of the Body as a Whole
(allergy, anoxia, anesthesia, anthropometry, drugs, exercise, immunity, sleep, and temperature regulation)

24551. Ashton, E. H.: Age changes in some bodily dimensions of apes. *Proc. zool. Soc. Lond., 124:* 587-594, 1954. Abstr: *B. A., 30:* No. 111, 1956.

24552. Beaudreau, G. S., R. A. Bonar, D. Beard, and J. W. Beard: Virus of avian erythroblastosis. II. Influence of host age and route of inoculation on dose-response. *J. nat. Cancer Inst., 17:* 91-100, 1956. Abstr: *B. A., 30:* No. 35130, 1956.

24553. Boné, E. L.: (The influence of general body size on the body proportions in man and other primates.) *Experientia, Basel, 11:* 169-172, 1955. Abstr: *B. A., 30:* No. 15832, 1956.

24554. Brooke, M. M., D. M. Melvin, R. Sappenfield, F. Payne, F. R. N. Carter, A. C. Offutt, and W. W. Frye: Studies of a water-borne outbreak of amebiasis, South Bend, Indiana. III. Investigation of family contacts. *Amer. J. Hyg., 62:* 214-226, 1955. Abstr: *B. A., 30:* No. 14340, 1956.

24555. Canitano, P., and R. Morsica: Valore e importanza del titolo antistreptolisinico nei soggetti sani in rapporta all'età e al sesso. *Terapia, 40:* 181-185, 1955. Abstr: *B. A., 30:* No. 35001, 1956.

24556. Casassa, P. M.: Rilievi sulla terapia con il siero antireticolo-citotossico (siero di Bogomoletz). *Gior. Geront., 6:* 334-344, 1958.

24557. Collins-Williams, C.: Allergy in children versus allergy in adults. *Canad. med. Ass. J., 78:* 276-279, 1958.

24558. Cordero, N., B. V. Javier, C. M. Paulino-Gonzalez, Z. B. Bagabaldo, and M. Rodriguez-Busuego: (Philippine physiological standards; body weight in relation to height and age for adults.) *Acta med. philippina, 13:* 417-440, 1957.

24559. Court-Brown, W. M.: Radiation-induced leukemia in man, with particular reference to the dose-response relationship. *J. chronic Dis., 8:* 113-122, 1958.

24560. Curtis, H. J., and R. Healey: Effects of radiation on ageing. *Adv. Radiobiol., —:* 261-265, 1958.

24561. Eckert, E. A., D. Beard, and J. W. Beard: Dose-response relations in experimental transmission of avian erythromyeloblastic leukosis. V. Influence of host age and route of virus inoculation. *J. nat. Cancer Inst., 15:* 1195-1207, 1955. Abstr: *B. A., 30:* No. 2198, 1956.

24562. Fokina, T. B.: (Morphological changes of blood picture in young rats of various ages in acute radiation sickness.) *Med. Radiol., 2:* (6), 26-37, 1957.

24563. Furuhata, T., and M. Eguchi: (The change of the agglutinin titer with age.) *Proc. Jap. Acad., 31:* 550-554, 1955.

24564. Gardiner, J. L.: The severity of cecal coccidiosis infection in chickens as related to the age of the host and the number of oocysts ingested. *Poult. Sci., 34:* 415-420, 1955. Abstr: *B. A., 30:* No. 3049, 1956.

24565. Goldin, A., J. M. Venditti, S. R. Humphreys, D. Dennis, and N. Mantel: Factors influencing the specificity of action of an antileukemic agent (aminopterin); host age and weight. *J. nat. Cancer Inst., 16:* 709-721, 1955. Abstr: *B. A., 30:* No. 19499, 1956.

24566. Grahn, D., and K. F. Hamilton: Genetic variation in the acute lethal response of four inbred mouse strains to whole body x-irradiation. *Genetics, 42:* 189-198, 1957. Abstr: *Biol. Sci., 9:* No. 3867, 1958.

24567. Hartmann, J.: (Complement determination. II. Determination of haemolytic complement activity in human sera as a function of age.) *Acta path. microbiol. scand., 42:* 164-172, 1958.

24568. Hennessy, V. A., D. M. Davenport, and T. Francis, Jr.: Studies of antibodies to strains of influenza virus in persons of different ages in sera collected in a postepidemic period. *J. Immunol., 75:* 401-409, 1955. Abstr: *B. A., 30:* No. 35006, 1956.

24569. Huang, C. H.: Studies on host factors in inapparent infection with Japanese B encephalitis; influence of age, nutrition and luminal-induced sleep on the course of infection in mice. *Acta virol., Praha (Engl. Ed.), 1:* 83-91, 1957.

24570. Kallman, R. F., and H. I. Kohn: Life-shortening by whole- and partial-body x-irradiation in mice. *Science, 128:* 301-302, 1958.

24571. Kohout, M., and R. Petrásek: (Development of thermoregulation and of changes in oxygen consumption in the golden hamster *(Mesocricetus auratus).*) *Acta Soc. zool. Bohem., 21:* 83-92, 1957. Abstr: *Biol. Sci., 8:* No. 4561, 1958.

24572. Krebs, A. T.: Techniques of biological measurements of low level radiation. *J. Aviat. Med., 25:* 331-337; 353, 1954. Abstr: *B. A., 30:* No. 18827, 1956.

24573. Kurth, G.: Zur Frage der Variabilität metrischer Merkmale und ihrer Verwendung im Vaterschaftsnachweis. Bemerkungen zu einer Arbeit H. W. Wünsches. *Homo, 5:* 17-21, 1954. Abstr: *B. A., 30:* No. 33555, 1956.

24574. Makarov, N. I., E. P. Makarova, and V. T. Bagaeva: (Seasonal and age variation in susceptibility to tularemia among the little ground squirrel *(Citellus pygmaeus Pall).*) *Zool. Zh., 34:* 652-657, 1955. Abstr: *B. A., 30:* No. 24911, 1956.

24575. Montoreano, F., and J. Rabenko: Control balistocardiográfico de la sensibilidad al tabaco en cancerosos pulmonares de edad avanzada. *Rev. Asoc. méd. argent., 71:* 208-212, 1957.

24576. Morpurgo, C. V.: Fisiopatologia dei vecchi in rapporto all'anestesia. *Minerva anest., Torino, 23:* 318-323, 1957.

24577. Nash, F. A.: Observations on real age and apparent age. *J. Amer. geriat. Soc., 6:* 515-521, 1958.

24578. Owen, M., H. A. Sissons, and J. Vaughan: Single injection of high dose of strontium-90 in rabbits. *Brit. J. Cancer, 11:* 229-248, 1957. Abstr: *Biol. Sci., 8:* No. 5219, 1958.

24579. Sagal, Z.: Insomnia in the aged. *Geriatrics, 13:* 463-466, 1958.

24580. Samson, F. E., Jr., W. M. Balfour, and N. A. Dahl: The effect of age and temperature on the cerebral energy requirement in the rat. *J. Geront., 13:* 248-251, 1958.

24581. Singer, I., R. Hadfield, and M. Lakonen: The influence of age on the intensity of infection with *Plasmodium berghei* in the rat. *J. infect. Dis., 97:* 15-21, 1955. Abstr: *B. A., 30:* No. 15106, 1956.

24582. Smith, J. E.: Studies on *Pasteurella septica.* I. The occurrence in the nose and tonsils of dogs. *J. comp. Path., 65:* 239-245, 1955. Abstr: *B. A., 30:* No. 17215, 1956.

24583. Spjut, H. J., and E. J. Eichwald: Induction of mammary tumours by injection of N-2-fluorenylacetamide into artificial caecal pouches in rats. *J. nat. Cancer Inst., 18:* 473-479, 1957. Abstr: *Biol. Sci., 8:* No. 5669, 1958.

24584. Standen, O. D.: The treatment of experimental schistosomiasis in mice; sexual maturity and drug response. *Ann. trop. Med. Parasit., 49:* 183-192, 1955. Abstr: *B. A., 30:* No. 20824, 1956.

24585. Volterrani, U.: (Age and inositol action on ganglioplegic hypothermia.) *Vitaminologia, 14:* 162-169, 1956. Abstr: *Chem. Abstr., 52:* No. 5664, 1958.

24586. Volterrani, U.: (Age, inositol, and neuroplegic hypothermia.) *Vitaminologia, 14:* 170-176, 1956. Abstr: *Chem. Abstr., 52:* No. 5664, 1958.

24587. Wolfe, H. R., C. Tempelis, A. Mueller, and S. Reibel: Precipitin production in chickens. XVII. Effect of massive injections of bovine serum albumin (BSA) at hatching on subsequent antibody production. *J. Immunol., 79:* 147-153, 1957. Abstr: *Biol. Sci. 10:* No. 652, 1958.

See also Nos. 24353, 24419, 24446, 24452, 24651, 24657, 24659, 24668, 24672.

### XII. Reproductive System

(ovaries, testis, See Endocrine System)

24588. Blumenthal, H. T., J. P. Vaeth, and S. D. Soule: Effect of non-ovarian hormones on the endometrium of castrate guinea pigs. *J. Geront., 13:* 261-268, 1958.

24589. Cianci, S.: (Alkaline phosphatase in vaginal walls of old women.) *Boll. Soc. med-chir., Catania, 25:* 275-284, 1957. Abstr: *Chem. Abstr., 52:* No. 5602, 1958.

24590. Cianci, S.: (Acid phosphatase changes in vaginal walls of old women after estrogen treatment.) *Boll. Soc. med.-chir., Catania, 25:* 285-291, 1957. Abstr: *Chem. Abstr., 52:* No. 5602, 1958.

24591. Day, L. H.: Age of women at completion of childbearing. *Publ. Hlth. Rep., Wash., 73:* 525-532, 1958.

24592. Hays, F. A.: Relation of age of dams to their reproductive ability and to the egg production and viability of their daughters. *Poult. Sci., 34:* 891-896, 1955. Abstr: *B. A., 30:* No. 13259, 1956.

24593. MacLeod, J., R. Z. Gold, and C. M. McLane: Correlation of the male and female factors in human infertility. *Fert. & Steril., 6:* 129-143, 1955. Abstr: *B. A., 30:* No. 13268, 1956.

24594. Ragab, M. T., A. A. Asker, and S. A. Hilmy: (Milk yield in the Egyptian cow as affected by age, dry period and month of calving.) *Indian J. dairy Sci., 7:* 171-177, 1954. Abstr: *B. A., 30:* No. 1205, 1956.

24595. Sjövall, T.: (Development of pregnancy in cases of criminal abortion with special references to older primigravidae.) *Svenska Läkartidn., 54:* 3870-3880, 1957.

24596. Torpin, R.: Uterine prolapse, enterocele, and the upper pelvic diaphragm. *Geriatrics, 13:* 450-462, 1958.

See also No. 24440.

### XIII. Respiratory System

24597. Alexander, J. K., J. Mise, E. W. Dennis, and R. L. Hershberger: Effects of racemic epinephrine inhalation on cardiopulmonary function in normal man and in patients with chronic pulmonary emphysema. *Circulation, N. Y., 18:* 235-248, 1958.

24598. Andersen, E. K.: (Lung oedema in mice after intranasal *Haemophilis pertussis* inoculation.) *Acta path. microbiol. scand., 40:* 248-266, 1957. Abstr: *Biol. Sci., 8:* No. 3540, 1958.

24599. Beresford, O. D.: Tuberculin skin sensitivity in old age. *Amer. Rev. Tuberc., 77:* 323-327, 1958. Abstr: *Geriatrics, 13:* 92A, 1958.

24600. Convit, J., and E. Rassi: Lepromin and tuberculin tests in Venezuelan leprosy foci, induction of lepromin reactivity by BCG vaccination. *Int. J. Leprosy, 22:* 303-310, 1954. Abstr: *B. A., 30:* No. 2257, 1956.

24601. Negre, L., and J. Bretey: *Les bacilles de Koch incomplètement évolués dans l'infection tuberculeuse.* Masson & Cie, Paris, 1955, 90 pp. Abstr: *B. A., 30:* No. 2240, 1956.

24602. Pierce, J. A., and R. V. Ebert: The elastic properties of the lungs in the aged. *J. Lab. clin. Med., 51:* 63-71, 1958.

See also No. 24479.

### XIV. Sense Organs and Perception

24603. Baumgartner, P., and M. Bernard: Sur la sénescence de la vision nocturne. *Bull. Acad. nat. Méd., Paris, 142:* 85-91, 1958.

24604. Bourlière, F., H. Cendron, and A. Rapaport: Modification avec l'âge des seuils gustatifs de perception et de reconnaissance aux saveurs salée et sucrée, chez l'homme. *Gerontologia, 2:* 104-112, 1958.

24605. Calvi, L. A., and A. Finzi: Rythme, longueur et signification des messages verbaux dans la presbyacousie. *Rev. oto-neuro-ophtal., Paris, 29:* 226-239, 1957.

24606. Fincham, E. F.: The proportion of ciliary muscular force required for accommodation. *J. Physiol., 128:* 99-112, 1955. Abstr: *B. A., 30:* No. 16447, 1956.

24607. Guth, S. K., A. A. Eastman, and J. F. McNelis: Lighting requirements for older workers. *Illum. Engng., 51:* 656-660, 1956. Abstr: *P. A., 31:* No. 7118, 1957.

24608. König, E.: (Pitch discrimination and age.) *Acta oto-laryng., Stockh., 48:* 475-489, 1957.

24609. Rosenberg, G., and A. Adams: Effect of age on peripheral vibratory perception. *J. Amer. geriat. Soc., 6:* 471-481, 1958.

24610. Wheeler, J. R.: The ageing eye. *Proc. roy. soc. Med., 51:* 17-22, 1958.

See also No. 24373.

### XV. Skeletal System

24611. Barnicot, N. A., and R. H. Hardy: The position of the hallux in West Africans. *J. Anat., Lond., 89:* 355-361, 1955. Abstr: *B. A., 30:* No. 9663, 1956.

24612. Bürger, M., and H. Knobloch: (Physiological value and nosological significance of measurement of the volume of the hand.) *Münch. med. Wschr., 99:* 581-587, 1957. Abstr: *Biol. Sci., 8:* No. 3934, 1958.

24613. Empel, W.: (Changes in the morphology of the skull of the wild rabbit (O.c.) in relation to age and to the local distribution in Poland.) *Folia morphol., 8:* 169-194, 1957.

24614. McKern, T. W.: Estimation of skeletal age from combined maturational activity. *Amer. J. phys. Anthrop., 15:* 399-408, 1957.

24615. Matera, R. F., A. V. Donnes, and B. A. Arias: Compresión radículomedular por discopatía cervical en los viejos. *Rev. Asoc. méd. argent., 71:* 102-108, 1957.

See also No. 24547.

XV-A. Skeletal System: *Bone*

24616. Barasa, A., and A. Gobetto: Il grande osso cardiaco dei bovini; istogenesi, struttura e trasformazioni con l'età. *Arch. biol., Liége, 68:* 541-560, 1957.

24617. Bertelsen, A.: (Orthopedic treatment problems in aged.) *Mskr. prakt. laegegern, 36:* 14-27, 1958.

24618. Bick, E. M.: General principles of fracture management in the aged. *Surg., Gynec. Obstet., 106:* 343-346, 1958. Abstr: *Geriatrics, 13:* 96A, 1958.

24619. Bodart, A., J. Sommelet, and F. Gentin: La fracture cervico-trochantérienne du vieillard doit être opérée. *Rev. méd. Nancy, 82:* 1206-1211, 1957.

24620. Little, K., L. H. Pimm, and J. Trueta: Osteoarthritis of the hip; an electron microscope study. *J. Bone Jt. Surg., 40-B:* 123-131, 1958.

24621. Pillet, J.: Fractures du plateau tibial externe chez les sujets de plus de 50 ans. *J. Chir. Méd., Paris, 75:* 72-86, 1958.

24622. Pygott, F.: Paget's disease of bone; the radiological incidence. *Lancet, 1:* 1170-1171, 1957. Abstr: *Biol. Sci., 8:* No. 5614, 1958.

24623. Robinson, R. A., and M. L. Watson: Crystal-collagen relationship in bone as observed in the electron microscope. III. Crystal and collagen morphology as a function of age. *Ann. N. Y. Acad. Sci., 60:* 529-628, 1955. Abstr: *B. A., 30:* No. 1448, 1956.

24624. Schechter, D. C., and C. K. Mervine, III: Current concepts in the management of osteoporosis. *J. Amer. geriat. Soc., 6:* 592-613, 1958.

24625. Sowden, E. M., and S. R. Stitch: Trace elements in human tissue. II. Determination of concentrations of stable strontium and barium in human bone. *Biochem. J., 67:* 104-109, 1957. Abstr: *Biol. Sci., 10:* No. 231, 1958.

24626. Stitch, S. R.: Trace elements in human tissue. I. Semi-quantitative spectrographic survey. *Biochem. J., 67:* 97-103, 1957. Abstr: *Biol. Sci., 10:* No. 231, 1958.

24627. Thieme, F. P., and C. M. Otten: The unreliability of blood typing aged bone. *Amer. J. phys. Anthrop., 15:* 387-397, 1957.

24628. Tonna, E. A.: The histochemistry of aging periosteum. *J. Bone Jt. Surg., 39A:* 674; 715, 1957.

See also Nos. 24427, 24466.

XVI. Skin and Integument

24629. Burgoon, C. F., Jr., and J. S. Burgoon: Aging and the cutaneous system. *Geriatrics, 13:* 391-401, 1958.

24630. Ellis, R. A.: Ageing of the human male scalp. Chap. *in:* W. Montagna and R. A. Ellis (Editors), *The Biology of Hair Growth.* Academic Press, Inc., New York, 1958.

24631. Hamilton, J. B.: Age, sex, and genetic factors in the regulation of hair growth in man; a comparison of Caucasian and Japanese populations. Chap. *in.:* W. Montagna and R. A. Ellis (Editors), *The Biology of Hair Growth.* Academic Press, Inc., New York, 1958.

24632. Hamilton, J. B., H. Terada, and G. E. Mestler: Studies of growth throughout the life span in Japanese. II. Beard growth in relation to age, sex, heredity, and other factors. *J. Geront., 13:* 269-281, 1958.

24633. Houck, J. C., and R. A. Jacob: Effect of age upon collagen and hexosamine content of rat skin. *Proc. Soc. exp. Biol., N. Y., 97:* 604-606, 1958.

24634. Kahnemann, F., and G. Moretti: Studio istologico ed istochimico di un probabile non comune caso di transizione, fra cheratosi senile e verruca seborroica del sopracciglio. *Ann. Ottalm. clin. Ocul., 83:* 605-611, 1957.

24635. Lee, M. M. C.: Physical and structural age changes in human skin. *Anat. Rec., 129:* 473-493, 1957.

24636. Mikhailova, V. N.: (Age changes of fibrous structures in the skin of sheep.) *C. R. Acad. Sci. U.R.S.S. (Dokl.), (Biol. Series),* —: (1), 89-97, 1958.

24637. Nelson, C. T. (Moderator), C. R. Rein, H. M. Robinson, Jr., M. B. Sulzberger, and E. F. Traub (Panelists): Panel discussion on the clinical management of skin disease in geriatric patients. *J. Amer. geriat. Soc., 6:* 575-591, 1958.

24638. Sobel, H., E. T. Wright, S. Gabay, and N. H. Nelson: Urinary steroids and the hexosamine-collagen ratio of dermal punches. *Gerontologia, 2:* 59-63, 1958.

24639. Young, A. W., Jr.: Dermatologic complaints presented by 330 geriatric patients. *Geriatrics, 13:* 428-434, 1958.

See also No. 24335.

XVII. Urogenital System
(includes prostate)

24640. Boone, A. W., and A. G. Smith: The elastic properties of normal ureter. *J. Urol., 73:* 481-486, 1955. Abstr: *B. A., 30:* No. 10203, 1956.

24641. Feinblatt, H. M., and J. C. Gant: Palliative treatment of benign prostatic hypertrophy; value of glycine-alanine-glutamic acid combination. *J. Maine med. Ass., 49:* 99-101, 1958.

24642. Irmisch, G. W.: Transurethral prostatic resection in the aged. *J. med. Soc. N. J., 55:* 108-111, 1958.

24643. Krähenbühl, C.: Ventral prostatectomy and prostatic extract on sex glands of rat. *Arch. int. Physiol., 65:* 360-375, 1957. Abstr: *Biol. Sci., 9:* No. 2035, 1958.

24644. Lino, E., and A. Anello: Funzione ormonica della prostata e nuova terapia medica dell'ipertrofia prostatica. *Minerva urol., Torino, 10:* 8-14, 1958.

24645. Ruiz Villanueva, E.: Adenoma de da próstata; síntomas y diagnóstico. *Med. esp., 39:* 85, 1958.

24646. Strukov, V. A.: (Operative treatment of incontinence in women and the anatomy of the structure closing the urinary bladder.) *Akush. gin., Moskva,* —: (5), 45-48, 1955. Abstr: *Biol. Sci., 8:* No. 4604, 1958.

## GERIATRICS

### I. General Orientation

24647. Beattie, J. W.: The development of geriatrics. *J. roy. Soc. promot. Hlth., Lond., 78:* 64-72, 1958.

24648. Feldman, D.: Community health; yesterday, today and tomorrow, a symposium, rehabilitation and geriatrics. *Bull. med. Libr. Ass., 46:* 39-42, 1958.

24649. Kotsovsky, D. A.: Robert Rössle als Altersforscher. *Med. Mschr., 12:* 85-87, 1958.

24650. Anonymous: Gerioptil. *Med. Klinik, 53:* 117, 1958.

### II. and III. Medical Care and Diagnosis (medical rehabilitation)

24651. Aslan, A.: Recherches sur l'action de la novocaine (substance $H_3$) action eutrophique et rajeunissante. *Gior. Geront., 6:* 246-270, 1958.

24652. Bini, V.: Suddivisione in stanzette di un camerone tipico. *Longevità, 6:* 16-17, 1958.

24653. Brown, F. R.: Nursing homes; public and private financing of care today. *Soc. Sec. Bull., 21:* 3-8, May 1958.

24654. Evans, L. S.: The geriatric patient. *J. nat. med. Ass., N. Y., 50:* 158-160, 1958.

24655. Feldman, H. S., and J. B. Clancy: A clinical study of ferroglycine sulfate complex in the geriatric patient; a report of a new diagnostic aid to measure iron reserves. *Geriatrics, 13:* 517-522, 1958.

24656. Garner, H. H., A. J. Simon, and M. S. Handelman: Management of chronic dependency in out-patient clinics by a comprehensive medical-psychiatry service. *J. Amer. geriat. Soc., 6:* 623-631, 1958.

24657. Giotti, A.: Dalla procaina quale farmaco stabilizzatore di membrana alla procaina quale fattore di ringiovanimento. *Gior. Geront., 6:* 289-324, 1958.

24658. Greppi, E.: Per un Dispensario Geriatrico. *Gior. Geront., 6:* 203-208, 1958.

24659. Guidi, G., and G. Scardigli: Prime considerazioni sull'uso della procaina in geriatria. *Gior. Geront., 6:* 325-333, 1958.

24660. Herbert, G.: Rehabilitation in a county nursing home. *Chron. Ill. News Lett., 9:* 5-6, April 1958.

24661. Howell, T. H.: Analysis of falls in old people. *J. Amer. geriat. Soc., 6:* 522-525, 1958.

24662. Kornbluth, A. W.: Use of Pacatal (mepazine) in nursing homes: a preliminary report. *Geriatrics, 13:* 477-480, 1958.

24663. Lowenthal, M., A. O. Posniak, and J. S. Tobis: Rehabilitation of the elderly double above-knee amputee. *Arch. phys. Med., 39:* 290-295, 1958. Abstr: *Geriatrics, 13:* 76A, 1958.

24664. Maragi, M.: I ricoveri di mendicità e le moderne esigenze dell'assistenza gerontologica. *Longevità, 6:* 3-6, 1958.

24565. Maréchal, R.: Beitrag zur Therapie der Alterserscheinungen. *Dtsch. med. J., 9:* 75-76, 1958.

24666. Monroe, R. T.: The mechanisms of the geriatric clinic and its place in the community. *New Engl. J. Med., 258:* 882-885, 1958.

24667. Nadel, M. B. J.: La reserpina nel trattamento colinergico del diabete mellito in malati arteriosclerotici. *Gior. Geront., 6:* 107-112, 1958.

24668. Nadel, M. B. J.: Percutaneous procaine blockade (PPB) in diseases of ageing and geriatrics. *Gior. Geront., 6:* 182-202, 1958.

24669. Natenshon, A. L.: Ritonic; a new geriatric supplement. *J. Amer. geriat. Soc., 6:* 534-538, 1958.

24670. New York. Health Information Foundation: The changing pattern of hospital use. *Progr. hlth. Serv., 7:* 1-6, May 1958.

24671. Niehans, P.: *La terapia cellulare.* Treveri Editore, Roma, 1957, 112 pp. Abstr: *Gior. Geront., 6:* 379-380, 1958.

24672. Parhon, C. J., and A. Aslan: La novocaina come fattore eutrofico e rigeneratore nel trattamento profilattico e curativo della vecchiaia. *Acta Geront., 8:* 3-23, 1958.

24673. Pomrinse, S. D.: How public health and private medicine cooperate to improve the care of the older person. *J. Amer. geriat. Soc., 6:* 482-488, 1958.

24674. Prigot, A., and A. de L. Maynard: Fortified broad spectrum antibiotics as adjuncts in the treatment of surgical infections of the young, the aged, and the debilitated patient. *Ann N. Y. Acad. Sci., 63:* 230-239, 1955. Abstr: *B. A., 30:* No. 32033, 1956.

24675. Répaci, M.: L'attività medica negli istituti per anziani. *Longevità, 6:* 41-45, 1958.

24676. Scardigli, G.: La terapia tissulare in geriatria. *Gior. Geront., 6:* 345-357, 1958.

24677. Sheard, M. H., E. P. Coyne, and P. Hammons: A trial of oral Metrazol and nicotinic acid in senile patients. *Geriatrics, 13:* 523-528, 1958.

24678. Simonenko, A. S.: (The treatment of hypertension by means of intra-arterial injection of novocaine.) *Publ Hlth. Byelorissia, U.S.S.R.,* —: (3), 70-71, 1957.

24679. Smigel, J. O.: Differential approaches to recent "mood" therapy in the aged. *Int. Rec. Med., 171:* 146-152, 1958. Abstr: *Geriatrics, 13:* 84A, 1958.

24680. Tibbitts, C.: Social change, aging, and public health nursing. *Nurs. Outlook, 6:* 144-147, 1958.

24681. Zilli, A.: Utilità di ormoni e vitamine nella terapia della vecchiaia. *Gior. Geront., 6:* 359-378, 1958.

24682. Anonymous: Licensing of hospitals, nursing homes, and homes for the aged. *Publ. Aid Ill., 25:* 69-76, April 1958.

See also Nos. 24467, 24517, 24556, 24641, 24644, 24838, 24839, 24843.

### IV. Disease
(chronic, infectious, and mental)

24683. Bettag, O. L.: Hospitalization of persons over 65 in Illinois state mental hospitals. *Geriatrics, 12:* 107-108, 1957. Abstr: *P. A., 32:* No. 324, 1958.

24684. Blackman, L. H., A. Glenn, and L. Olinger: The combination of tranquilizer, sympathomimetic drug and vitamins in the treatment of elderly psychotic patients. *J. Amer. geriat. Soc., 6:* 554-559, 1958. Also *in: Amer. J. Psychiat., 114:* 837-838, 1958.

24685. Cameron, D. E.: The use of nucleic acid in aged patients with memory impairment. *Amer. J. Psychiat., 114:* 943, 1958.

24686. Cleveland. Benjamin Rose Hospital Staff: Multidisciplinary study of illness in aged persons. I. Methods and preliminary results. *J. chronic Dis., 7:* 332-345, 1958.

24687. Cosin, L. Z., F. Post, C. Westropp, and M. Williams: Persistent senile confusion; study of 50 consecutive cases. *Int. J. soc. Psychiat., 3:* 195-202, 1957. Abstr: *Geriatrics, 13:* 64A, 1958.

24688. DiCicco, L., and D. Apple: Health needs and opinions of older adults. *Publ. Hlth. Rep., Wash., 73:* 479-487, 1958.

24689. Dodge, H. J., H. E. Griffin, R. L. Gauld, and Y. S. Kim: Epidemic hemorrhagic fever in a Korean farm population. *Amer. J. Hyg., 63:* 38-51, 1956. Abstr: *B. A., 30:* No. 20037, 1956.

24690. Dunn, J. E., Jr.: Preliminary findings of the Memphis-Shelby county uterine cancer study and their interpretation. *Amer. J. publ. Hlth., 48:* 861-873, 1958.

24691. Garcia Herrera, E.: El trastornado, trastornador. *Medicina, México,* 38: 34-41, 1958.

24692. Gerfeldt, E.: Differenzierte Krankheitsanfälligkeit und Lebensalter. *Vita Humana, 1:* 19-42, 1958.

24693. Hochbaum, G. M.: *Public participation in medical screening programs; a socio-psychological study.* Publ. Hlth. Serv., Washington, 1958, No. 572, 23 pp.

24694. Janzarik, W.: Zur Problematik schizophrener Psychosen im höheren Lebensalter. *Nervenarzt, 28:* 535-542, 1957.

24695. Kauchtschischwili, G. M.: Osservazioni ed esperienze terapeutiche in tema di psicopatie senili. *Gior. Geront., 6:* 113-134, 1958.

24696. LaVeck, G. D., J. F. Winn, and S. F. Welch: Inapparent infection with western equine encephalitis virus; epidemiologic observations. *Amer. J. publ. Hlth., 45:* 1409-1416, 1955. Abstr: *B. A., 30:* No. 14329, 1956.

24697. Lilienfeld, A. M.: Possible existence of predisposing factors in the etiology of selected cancers of nonsexual sites in females. *Cancer, 9:* 111-122, 1956. Abstr: *B. A., 30:* No. 28845, 1956.

24698. Liu, W.: Basal cells in vaginal smears of patients with carcinoma of the cervix. *Cancer, 10:* 522-528, 1957. Abstr: *Biol. Sci., 10:* No. 850, 1958.

24699. Longshore, W. A., Jr., I. M. Stevens, A. C. Hollister, Jr., A. Gittelsohn, and E. H. Lennette: Epidemiologic observations on acute infectious encephalitis in California, with special reference to the 1952 outbreak. *Amer. J. Hyg., 63:* 69-86, 1956. Abstr: *B. A., 30:* No. 20040, 1956.

24700. Panse, F., and H. Scheibe: Die Zunahme der pflegebedürftigen Alternskranken. *Dtsch. med. Wschr., 83:* 296-300, 1958.

24701. Querido, A.: (Re-evaluation of geriatric diseases.) *Ned. Tijdschr. Geneesk., 102:* 209-211, 1958.

24702. Ross, C. H.: Cancer in geriatrics. *J. Mich. med. Soc., 57:* 536-545, 1958. Abstr: *Geriatrics, 13:* 72A; 74A, 1958.

24703. Taylor, S.: The survey of sickness, 1943-52; was our survey really necessary? *Lancet, 1:* 521-523, 1958.

24704. Tomson, F. I.: Multiphasic screening program in a low income area. *Publ. Hlth. Rep., Wash., 73:* 533-536, 1958.

24705. U. S. Department of Health, Education and Welfare. Public Health Service: *Origin and program of the U. S. National Health Survey.* U. S. Govt. Print. Office, Washington, May 1958, Series A-1, 36 pp.

24706. U. S. Department of Health, Education and Welfare. Public Health Service: *Health statistics; preliminary report on disability, United States, July-September 1957.* U. S. Govt. Print. Office, Washington, June 1958, 30 pp.

24707. U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance. Division of Program Analysis. Actuarial Branch: *Selected data on characteristics of applicants under the disability provisions of the Old-Age, Survivors, and Disability Insurance Program, January-June 1957.* The Branch, Washington, May 1958, 32 pp. (Mimeogr.).

24708. Wenger, P.: A comparative study of the aging process in groups of schizophrenic and mentally well veterans. *Geriatrics, 13:* 367-370, 1958.

24709. Zeh, W.: Altersfärbung cyclothymer Phasen. *Nervenarzt, 28:* 542-545, 1957.

See also Nos. 24378, 24393, 24404, 24406, 24451, 24483, 24484, 24512, 24575, 24639, 24670.

V. HYGIENE

24710. Kutner, B.: Health education in senior citizens' programs. *Amer. J. publ. Hlth., 48:* 622-626, 1958.

24711. Lenzner, A. S.: Mental health problems of the aging. *J. Jewish commun. Serv., 33:* 147-152, 1956. Abstr: *P. A., 32:* No. 327, 1958.

See also No. 24352.

VI. PREMATURE AGING (progeria)

24712. Grant, A. P.: Werner's syndrome (progeria in the adult). *Ulster med. J., 26:* 65-70, 1957.

24713. Von Deschwanden-Müller, B., and A. Gilardi: Über einen seit Geburt beobachteten Fall von Cutis marmorata teleangiectatica congenita mit progerieähnlichen Symptomen. *Schweiz. med. Wschr., 87:* 1464-1468, 1957.

VII. SURGERY

24714. Bertrand, P., and H. Fernoux: Volvulus du grêle chez une femme de 95 ans; large entérectomie; guérison. *Lyon chir., 54:* 113-114, 1958.

24715. Davey, W. W.: Gastrectomy in the aged. *Med. World, Lond., 88:* 115-120, 1958.

24716. Ignatius, J. A., and G. F. Madding: Biliary tract surgery in the aged patient. *Gastroenterology, 34:* 694-699, 1958. Abstr: *Geriatrics, 13:* 76A, 1958.

24717. Jung, A.: De la chirurgie et du risque opératoire chez les malades âgés. *Progr. méd., Paris, 86:* 3-4, 1958.

24718. Lovo, G. F.: Considerazioni su possibilità e risultati di interventi di chirurgia riparatrice nell'età avanzata. *Acta Geront., 8:* 37-49, 1958.

24719. McFadden, G. D.: The responsibility of the surgeon to the aged patient. *Ulster med. J., 26:* 1-16, 1957.

24720. Meyer, K. A., H. A. Jacobson, and P. Beaconsfield: Surgical treatment of the octogenarian. *J. int. Coll. Surgeons, 29:* 263-273, 1958. Abstr: *Geriatrics, 13:* 68A; 71A, 1958.

See also Nos. 24477, 24674.

PSYCHOLOGICAL PROCESSES

24721. Aaronson, B. S.: Age and sex influences on MMPI profile peak distributions in an abnormal population. *J. consult. Psychol., 22:* 203-206, 1958.

24722. Beibin, E.: Methods of training older workers. *Ergonomics, 1:* 207-221, 1958.

24723. Bender, I. E.: Changes in religious interest; a retest after 15 years. *J. abnorm. (soc.) Psychol., 57:* 41-46, 1958.

24724. Botwinick, J., J. F. Brinley, and J. S. Robbin: The interaction effects of perceptual difficulty and stimulus exposure time on age differences in speed and accuracy of response. *Gerontologia, 2:* 1-10, 1958.

24725. Busse, E. W., and C. R. Nichols: Emotional disturbances of older people; treatment of some common disorders. *Med. Times, N. Y., 86:* 263-268, 1958.

24726. Freeman, G. L.: A high-level interest-values reference test for counselling pre-retirants. *J. Psychol., 46:* 121-139, 1958.

24727. Giese, H.: Das Altersbild sexueller Perversionen. *Nervenarzt, 28:* 553-554, 1957.

24728. Glanzer, M., R. Glaser, and M. Richlin: *Development of a test battery for study of age-related changes in intellectual and perceptual abilities.* Air Univ., Sch. Aviat. Med., Randolph Air Force Base, Texas, March 1958, 24 pp.

24729. Griew, S.: Age changes and information loss in performance of a pursuit tracking task involving interrupted preview. *J. exp. Psychol., 55:* 486-489, 1958.

24730. Gruen, A.: Psychological testing with the older client; a case of paresis. *J. project. Techniques, 22:* 26-32, 1958.

24731. Havighurst, R. J.: Rewards of maturity for the teacher. *Educ. Forum, 20:* 145-150, 1956.

24732. Kleemeier, R. W.: Somatopsychologic effects of illness in the aged person. *Geriatrics, 13:* 441-449, 1958.

24733. Kleemeier, R. W.: La funzione del "counseling" negli istituti per anziani. *Longevità, 6:* 57-60, 1958.

24734. Klopfer, W. G.: The application of the Rorschach technique to geriatrics. *In:* Klopfer, W. G., et al., *Developments in the Rorschach Technique.* World Book Co., New York, 1954, vol. 2.

24735. Klopfer, W. G.: Psychologic stresses of old age. *Geriatrics, 13:* 529-531, 1958.

24736. Lakin, M.: Affective tone in human figure drawings by institutionalized aged and by normal children. *J. Amer. geriat. Soc., 6:* 495-500, 1958.

24737. Larsson, K.: Age differences in the diurnal periodicity of male sexual behavior. *Gerontologia, 2:* 64-72, 1958.

24738. Lehman, H. C.: The chemist's most creative years. *Science, 127:* 1213-1222, 1958.

24739. Meissner, W. W.: Affective response to psychoanalytic death symbols. *J. abnorm. (soc.) Psychol., 56:* 295-299, 1958.

24740. Menger, P., J. J. Roussin, and G. de Lapouge: Psychose ménopausique après un rapport sexuel insolite; problème étiologique. *Ann. méd.-psychol.,* 116, *1:* 139-144, 1958.

24741. Milne, G. G.: Deterioration and over-learning. *Aust. J. Psychol., 8:* 163-172, 1956. Abstr: *P. A., 32:* No. 332, 1958.

24742. Mitchell, J.: Speech and language impairment in the older patient; some problems in management. *Geriatrics, 13:* 467-476, 1958.

24743. Mysak, E. D., and T. D. Hanley: Aging processes in speech; pitch and duration characteristics. *J. Geront., 13:* 309-313, 1958.

24744. Olsen, I. A., and J. H. Elder: A word-association test of emotional disturbance in older women. *J. Geront., 13:* 305-308, 1958.

24745. Ralph, K. M.: Selective recall of completed and incompleted tasks as a function of age and instructions. *Disserta. Abstr., 16:* 1728-1729, 1956. Abstr: *P. A., 31:* No. 5738, 1957.

24746. Riegel, K. F.: Ergebnisse und Probleme der psychologischen Alternsforschung. *Vita Humana, 1:* 52-64; 111-127, 1958.

24747. Riegel, K. F.: *Eine Untersuchung über intellektuelle Funktionen älterer Menschen.* Univ. Hamburg, Psychol. Inst., Hamburg, Jan. 1958, 150 pp.

24748. Sopchak, A. L.: Spearman correlations between MMPI scores of college students and their parents. *J. consult. Psychol., 22:* 207-209, 1958.

24749. Stern, J. A.: Effect of frontal cortical lesions on activity wheel and open field behaviour. *J. genet. Psychol., 90:* 203-212, 1957. Abstr: *Biol. Sci., 9:* No. 2085, 1958.

24750. Tachabana, K.: (Studies on senescence.) *Memoirs of the Faculty of Letters, Osaka Univ., 6:* 1-357, March 1958.

24751. Tuckman, J., and M. Lavell: Study of suicide in Philadelphia. *Publ. Hlth. Rep., Wash., 73:* 547-553, 1958.

24752. Tuckman, J., and I. Lorge: Attitude toward aging of individuals with experiences with the aged. *J. genet. Psychol., 92:* 199-204, 1958.

24753. van Zonneveld, R. J.: An orientation study of the memory of old people. *Geriatrics, 13:* 532-534, 1958.

24754. Vischer, A. L.: Zur Psychologie der zweiten Lebenshälfte. *Schweiz. R. Med., 47:* 361-368, 1958.

24755. Welford, A. T.: *Ageing and human skill.* Oxford Univ. Press, London, 1958, vi, 300 pp.

24756. Willingham, W. W.: The relation of age to success in flight training. *J. Aviat. Med., 29:* 136-138, 1958.

24757. Wimer, R. E., and B. T. Wigdor: Age differences in retention of learning. *J. Geront., 13:* 291-295, 1958.

See also Nos. 24308, 24361, 24362, 24442, 24685, 24688, 24708, 24772, 24787.

## SOCIAL AND ECONOMIC ASPECTS

### I. Accidents

24758. U. S. Department of Health, Education and Welfare. Public Health Service: *Preliminary report on number of persons injured; United States, July-December 1957.* U. S. Govt. Print. Office, Washington, May 1958, Series B-3, 32 pp.

### III. Demography

24759. Japan. Ministry of Health and Welfare: *A brief report on public health administration in Japan; 1957.* The Ministry, Tokyo, Sept. 1, 1957, 42 pp.

24760. Minoru, T.: (The population problem.) *Jap. Quart., 5:* 10 pp., Jan.-March 1958.

24761. Schmid, C. F., E. H. MacCannell, and M. D. Van Arsdol, Jr.: The ecology of the American city; further comparison and validation of generalizations. *Amer. sociol. Rev., 23:* 392-401, 1958.

24762. Scott, F. G.: Intrastate migration of the preaged and the aged in Texas, 1935-1940. *J. Geront., 13:* 296-304, 1958.

24763. Sheldon, H. D., and C. Tibbitts: *The older population of the United States.* John Wiley & Sons, Inc., New York, 1958, xiii, 223 pp.

24764. Anonymous: Enquête sur la démographie universitaire française en 1955-56. *Concours méd., 80:* 1228-1230, 1958.

### IV. Economic Problems

24765. U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance. Division of Program Analysis: *National survey of Old-Age and Survivors Insurance beneficiaries; 1957.* The Division, Washington, June 1958, 22 pp.

### IV-B. Economic Problems: *Employment*

24766. Bertozzi, E., and V. Sage: A study of the older nurse in Rhode Island. *Nurs. Res., 7:* 11-22, 1958.

24767. Blocker, C. E.: The age factor in employees' job problems. *Personnel, 32:* 353-356, 1956. Abstr: *P. A., 31:* No. 1802, 1957.

24768. Chicago. Senior Achievement, Inc.: *Senior Achievement, Inc.; Chicago experiment.* (Film). Television Center, 310 Maynard Street, Ann Arbor, Mich., 30 min., rental charge $5.00.

24769. Finsbury Health Center: *The Finsbury employment scheme for the elderly.* The Center, London, Jan. 1956, 5 pp.

24770. Lapierre, E., E. Luchterhand, and J. Pilote: *The Arvida Placement System. Part I. Review of initial operation; June 1955 to December 1956.* Aluminum Co. Canada, Ltd., and Arvida Works, Montreal, April 1957, No. EP1, 14 pp.

24771. Law, N. R.: Aging teachers. *Sch. Rev., 63:* 341-345, 1955.

24772. McMahan, C. A., and J. W. Combs, Jr.: *The age of military leaders and expansion of the Armed Forces.* USAF Personn. Train. Res. Cent., 1956, Res. Rep. No. AFPTRC-TN-56-62, 11 pp. Abstr: *P. A., 31:* No. 8925, 1957.

24773. Metrop. Life Insur. Co.: Older people at work. *Statist. Bull. Metrop. Life Insur. Co., 39:* 6-8, June 1958.

24774. Murrell, K. F. H., and S. Griew: Age structure in the engineering industry; a study of regional effects. *Occup. Psychol., Lond., 32:* 86-88, 1958.

24775. U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance. Division of Program Analysis: Quarterly summary of earnings, employment and benefit data. *Bur. Old Age & Surv. Insur., Div. Prog. Anal., 18:* (2), 1-25, 1958.

24776. U. S. Department of Labor. Bureau of Employment Security: *Services to older workers by the Public Employment Service.* The Bureau, Washington, 1957, 126 pp.

24777. Anonymous: Establishment of the retired professors registry. *Physiologist, 1:* (3), 36-40, 1958.

See also Nos. 24607, 24722, 24763.

IV-C. ECONOMIC PROBLEMS: *Retirement and Pensions*
(See also Social Security)

24778. Bronson, D. C.: *Concepts of actuarial soundness in pension plans.* Richard D. Irwin, Inc., Homewood, Ill., 1957, xix, 183 pp.

24779. Button, D. S.: Retirement practices of state *universities. AAUP Bull., 43:* 492-497, 1957.

24780. Chandler, B. J., and P. V. Petty: Retirement. Chap. 13, *in: Personnel Management in School Administration.* World Book Co., Yonkers-on-Hudson, N. Y., 1955, pp. 359-384.

24781. Howard, W. M.: Retirement plans for small municipalities. *Econ. Leaflets, 17:* 1-4, June 1958.

24782. Huggett, A. J., and T. M. Stinnett: Retirement systems for teachers. Chap. 7, *in: Professional Problems of Teachers.* Macmillan Co., New York, 1956, pp. 157-178.

24783. Murphy, J. T.: Retirement policies of selected Iowa firms. *Bull. Inst. Geront. (State Univ. Iowa), 5:* (Suppl. 6), 3-6, 1958.

24784. National Education Association. Department of Classroom Teachers and Research Division: *Teacher retirement.* The Association, Washington, 1957, 24 pp.

24785. National Education Association. National Council on Teacher Retirement: *Proceedings of the annual meeting February 23, 1955; February 16, 17, 18, 1956; February 14, 15, 16, 1957.* The Association, Washington, (Published annually).

24786. National Education Association. Research Division: *One criterion for evaluating retirement benefits for teachers.* The Association, Washington, Oct. 1956, 76 pp.

24787. National Social Welfare Assembly, Inc. National Committee on the Aging: *Current developments in preparation for retirement.* The Committee, New York, May 1958, 31 pp.

24788. Stewart, L. H.: Some needed research on problems of retirement. *Educ. Admin. Supervision, 42:* 68-71, Feb. 1956.

24789. Turner, R. H.: Retirement practices in selected colleges and universities. *AAUP Bull., 42:* 662-666, 1956.

24790. U. S. Department of Health, Education and Welfare. Social Security Administration. Division of Program Research: *Canadian pension plans and the employment of older workers.* The Division, Washington, Feb. 11, 1958, No. 4, 4 pp.

24791. Anonymous: (Belgium. New legislation on pensions for salaried employees.) *Bull. int. Soc. Sec. Ass., 10:* 524-533, Dec. 1957.

See also Nos. 24726, 24832.

V. EDUCATION
(adult)

24792. Glancy, K. E.: *Noncredit adult education at the university level.* Div. Educ. Ref., Purdue Univ., Lafayette, Ind., April 1958, No. 88, 23 pp.

24793. Anonymous: Learning to live. *Monsanto Mag., St. Louis,* —: 21-23, Oct.-Nov. 1957.

VI. HOUSING AND CARE

24794. Berggren, A.: Esperienze svedesi nella protezione degli anziani. *Longevità, 6:* 34-36, 1958.

24795. Berggren, A., and B. Boustedt: La moderna casa per anziani in Svezia. *Longevità, 6:* 37-40, 1958.

24796. Bini, V.: Istituto per 96 anziani. *Longevità, 6:* 49-52, 1958.

24797. Carlotti, G.: Il lavoro nelle case di riposo. *Longevità, 6:* 7-8, 1958.

24798. Chicago. Jewish Federation. Drexel Home, Inc.: *A manual of job descriptions.* The Home, Chicago, May 9, 1958, 79 pp.

24799. Federal Housing Administration: *Housing for the elderly; how FHA helps.* U. S. Govt. Print. Office, Washington, 1957, 17 pp.

24800. Federal Housing Administration: *Report of Industry Advisory Committee on housing for the elderly.* The Administration, Washington, May 9-10, 1957, 41 pp.

24801. Federal Housing Administration. (Prepared by M. Cleverley): *Housing for the elderly.* The Administration, Washington, Sept. 17, 1957, 6 pp.

24802. Federal Housing Administration. (Prepared by M. Cleverley): *Housing for the elderly.* The Administration, Washington, Nov. 8, 1957, 4 pp.

24803. Federal Housing Administration. (Prepared by M. Cleverley): *Housing for the elderly; annual report for Norman P. Mason, Commissioner, FHA.* The Administration, Washington, Dec. 31, 1957, 12 pp.

24804. Federal Housing Administration. (Prepared by M. Cleverley): *Starting a home for the retired. Suggestions by Edward P. O'Rear, general manager of Pacific Homes, 5250 Santa Monica Boulevard, Los Angeles 29, California.* The Administration, Washington, April 11, 1958, 11 pp.

24805. Federal Housing Administration. Division of Research and Statistics: *Housing for the elderly; projects and proposals as of March 31, 1958.* The Division, Washington, 1958, 3 pp.,

24806. Federal Housing Administration. Housing and Home Finance Agency. (Prepared by E. E. Ashley): *A happy home for the later years.* The Agency, Washington, 1957, 9 pp.

24807. Federal Housing Administration. Housing and Home Finance Agency. (Prepared by E. E. Ashley): *Older people and their housing needs.* The Agency, Washington, 1957, 22 pp.

24808. Matsuoka, S., S. Nishikawa, T. Ogawa, M. Yoshimasu, K. Watanabe, R. Kurita, and Y. Ômura: *(Surveys on the Old People's Home in Japan. V. Sanitation in the Old People's Home.)* The Authors, Tokyo Univ., 1958, 3 pp.

24809. Pagani, A.: La mobilità degli ospiti anziani dell'Istituto Inabili di Milano. *Longevità, 6:* 46-48, 1958.

24810. Philadelphia Health and Welfare Council. Division on the Aging: *Health guide for institutions serving older people.* The Division, Philadelphia, 1957.

24811. Philadelphia Housing Association. Committee on Housing for Older People: *Toward independent living for older people; a report on housing and community services.* The Committee, Philadelphia, Jan. 1958, 53 pp.

24812. Rancati, A.: La struttura dei servizi negli istituti per anziani; relazione al convegno UNEBA sugli Istituti per anziani. *Longevità, 6:* 18-21, 1958.

24813. Thiébaud, A.: La Maison de Retraite départementale de Villers-Cotterets. *Techn. hosp., Paris, 13:* 51-53, 1958.

See also Nos. 24682, 24763, 24845.

### VIII. Medical Care

24814. Polner, W.: Methods of providing voluntary health insurance for the aged. *Chron. Ill. News Lett., 9:* 2-4, April 1958.

24815. U. S. Department of Health, Education and Welfare. Social Security Administration. Division of Program Research: *Governmental expenditures and other public financial support for personal medical care of persons aged 65 and over; 1955-56.* The Division, Washington, Feb. 4, 1958, No. 3, 9 pp.

24816. U. S. Department of Health, Education and Welfare. Social Security Administration. Division of Program Research: *Sources of payment for general hospital care; results from a pilot study in New York State.* The Division, Washington, Feb. 24, 1958, No. 6, 9 pp.

24817. Weil, T. P.: Prepaid medical care plans for our senior citizens. *Hosp. Mgmt., 85:* 50-52, March 1958.

See also Nos. 24318, 24819.

### IX. Social Problems
(includes social adjustment)

24818. Barry, M. C.: Planning for older persons in an urban community. *Geriatrics, 13:* 535-541, 1958.

24819. Benedetti, C.: Di alcuni problemi medico-sociali della vecchiaia. *Minerva med., Torino, 49:* 277-284, 1958.

24820. Havighurst, R. J.: Funzione sociale e struttura biologica nell'invecchiamento. *Longevità, 6:* 1-2, 1958.

24821. Jensen, H. E.: Sociological aspects of aging. *Publ. Hlth. Rep., Wash., 73:* 569-576, 1958.

24822. Mathiasen, G.: The National Committee on the Aging. *Newsletter (Geront. Soc.), 5:* 5; 8, March 1958.

24823. Myers, R. J.: Canadian programs for the aged. *Soc. Sec. Bull., 21:* 13-15; 24-25; 27, May 1958.

24824. New Jersey. State. Old Age Study Commission: *A positive policy toward aging.* The Commission, Trenton, 1957, 217 pp.

24825. New York. Community Research Associates, Inc.: *Current social research; an inventory.* The Association, New York, 1957, ix, 205 pp.

24826. Spector, S.: The Council of State Governments and the aging. *Newsletter (Geront. Soc.), 5:* 4; 8, March 1958.

24827. Still, H. N.: American National Red Cross programs related to the aging. *Newsletter (Geront. Soc.), 5:* 6; 8, March 1958.

24828. U. S. Department of Health, Education and Welfare. Special Staff on Aging: *Programs of the Department of Health, Education and Welfare affecting older persons.* U. S. Govt. Print. Office, Washington, Jan. 1958, 31 pp.

See also Nos. 24326, 24680, 24811.

### X. Social Groups

24829. U. S. Department of Commerce. Bureau of the Census: *Marital status, economic status, and family status; March 1957.* Curr. Pop. Repts., Pop. Charact., March 19, 1958, Series P-20, No. 81, 15 pp.

24830. U. S. Department of Health, Education and Welfare. Public Health Service. National Office of Vital Statistics: Divorces and annulments; detailed statistics for reporting areas, 1956. *Vit. Statist., Spec. Rep., Nat. Summaries, 48:* (2), 25-46, 1958.

24831. Wright, C. R., and H. H. Hyman: Voluntary association memberships of American adults; evidence from national sample surveys. *Amer. sociol. Rev., 23:* 284-294, 1958.

See also No. 24723.

### XI. Social Security

24832. National Education Association. Research Division: *Technical problems in social security coverage for public-school teachers.* The Association, Washington, Aug. 1955, 16 pp.

24833. Radus-Zen'Kovich, V. A.: (History of Soviet Social Security.) *Sovetsk. med., 21:* (10), 139-143. 1957.

24834. U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance: *Tables for reduction of old-age and wife's benefits under the 1956 amendments to the Social Security Act.* U. S. Govt. Print. Office, Washington, 1958, 216 pp.

24835. U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance. Division of Program Analysis: Old-age, survivors, and disability insurance; development of agricultural coverage. *Soc. Sec. Bull., 21:* 3-6, June 1958.

24836. U. S. Department of Health, Education and Welfare. Social Security Administration. Division of Program Research: *Recent changes in British social insurance programs.* The Division, Washington, Feb. 13, 1958, No. 5, 6 pp.

See also No. 24765.

## XII. Social Services and Social Work

(Recreation and social aspects of rehabilitation. Medical rehabilitation under Geriatrics, Medical Care)

24837. Aradas, A., and R. Bonazzi: Esame dei diversi aspetti della gerontologia; in rapporto alle sue applicazioni sociali ed individuali. *Longevità, 6:* 62-66, 1958.

24838. Bloch, H. I.: Casework services in a geriatric clinic. *Soc. Casework, 39:* 228-235, 1958.

24839. Booth, E. M., and H. Droller: A special home help scheme. *Med. Pr., 239:* 577-581, 1958.

24840. Chicago. Jewish Federation. Drexel Home, Inc.: *A manual for volunteers.* The Home, Chicago, Jan. 1958, 31 pp.

24841. Donahue, W. T., W. W. Hunter, D. H. Coons, and H. K. Maurice (Editors): *Free time; challenge to later maturity.* Univ. Mich. Press, Ann Arbor, 1958, xii, 172 pp.

24842. Paolillo, G.: Tempo libero ed attività ricreativa. *Longevità, 6:* 15, 1958.

24843. Tarugi, P.: Contributo del servizio sociale all'assistenza degli ospiti anziani; relazione al Corso Residenziale per Dirigenti d'Istituto, Meina. *Longevità, 6:* 13-15, 1958.

24844. U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance: *Report of a study of referral services by Old-Age and Survivors Insurance District Offices.* The Bureau, Baltimore, 1957, 27 pp.

24845. Wershow, H. J.: The social worker's service to residents of a home for the aged. *Geriatrics, 13:* 371-376, 1958.

### POPULAR ARTICLES

24846. Peale, N. V., and R. C. Peale: *Live longer and better.* Guideposts, Carmel, N. Y., 1958.

24847. Stieglitz, E. J.: Do you want to live longer? *U. S. News, 54:* 74-83, Feb. 14, 1958.

24848. Still, J. W.: Why can't we live forever? *Better Homes and Gardens,* —: 36-37; 85-86, Aug. 1958.

# Author Index to Current Periodical Literature

## (January-April-July-October, 1958)

### Reference is given to serial numbers


**A**

Aaring, C. D., 23276.
Aaronson, B. S., 24049, 24721.
Abbatt, J. D., 23045.
Abbe, L. M., 23257.
Abelanet, R., 23903.
Abitbol, V., 23102.
Ábrahám, K., 23752.
Abric, J., 22475.
Abt, K., 22454.
Achaintre, A., 22670.
Achallé, J. Y., 22671.
Achallé, P., 22671.
Acsádi, G., 22782, 22783.
Actis-Dato, A., 24477.
Adam, M., 22358.
Adams, A., 24609.
Adams, K. M., 23887.
Adams, W. E., 24115.
Adamson, T. L., 23103.
Adler, M., 23530.
Adriani, J., 23164.
Afifi, S. E. D., 24354.
Aftergood, L., 22295.
Agarwala, S. C., 23104.
Agmon, J., 23703.
Agnew, E., 22308.
Agostini, C., 23075.
Aguirre, A., 24426.
Akulinin, A. A., 23153.
Albanese, A. A., 23033, 23683.
Albany (N. Y.). New York State Conference, 23445.
Albert, I. C., 22618.
Aldes, J. H., 22619.
Alef, U., 23105.
Alexander, C., 22980, 24322.
Alexander, J. K., 24597.
Alexander, N. M., 24413.
Alfin-Slater, R. B., 22295.
Alizade, B. N., 23790.
Allalouf, D., 23703.
Allara, E., 22386, 23573.
Alleger, D. E., 22846.
Allen, A. R., 23962.
Allen, G. H., 23596.
Allen, J. C., 22383.
Allen, M. D., 24355.
Allen, M. L., 23159.
Allen, N. N., 24524.
Alliani, E., 22461.
Alström, C. H., 24050.
Alsup, B., 22296, 22299, 22300.
Altieri, A., 22596, 22597.
Altschul, R., 24447.
Alvarez, W. C., 23134, 23429, 24237, 24259.
Amado, J. R., 23106.
Amasio, C., 22730.
Amerault, T. E., 22489.
American Dietetic Association. Diet Therapy Section, 22297.
American Medical Association. Council on Medical Service, 22620.
American Nursing Home Association, 22621.
American Psychological Association. Division 20. Maturity and Old Age, 24307.
Amon, F., 24260.
Andersen, E. K., 24598.
Andersen, R., 22598.
Anderson, C. A., 24201.
Anderson, D. E., 22663.
Anderson, J. E., 22749, 24442.
Anderson, O. L., 22672, 22673.
Anderson, R. M., 24024.
Andervont, H. B., 23843.
Andrada, J. A., 23773.
Andreev, I. G., 22434.
Andrew, W., 24443.
Andriashchenko, A. A., 23888.
Andrus, E. P., 23495.
Anello, A., 24644.
Angervall, G., 23047.
Annoni, G., 23684.
Ansell, J. S., 24116.
Antonaci, B. L., 23735.
Antonini, F. M., 22341, 22951, 23277, 23712.
Antoniotti, F., 24350.
Anuchin, A. W., 23586.
Apasyev, P. T., 23147.
Appel, K. E., 24113, 24134.
Apple, D., 24688.
Aradas, A., 24837.
Aravanis, C., 23736.
Arias, B. A., 23833, 24615.
Arias, B. J., 23004, 23343.
Aring, C. D., 23237.
Arlet, J., 23950.
Armenio, G., 23791.
Armitage, P., 23278.
Arnold, E. T., Jr., 22609.
Arnold, H., 22558, 23951.
Aroldi, A., 23062.
Arrien Echevarri, A., 22481.
Arrighi, A. A., 22513
Arslan, M., 23919.
Ashley, E. E., 24238, 24239, 24240.
Ashton, E. H., 24551.
Asker, A. A., 24594.
Aslan, A., 24001, 24002, 24651, 24672.
Asley, E. E., 24262.
Association Internationale de la Sécurité Sociale, 24168.
Astaldi, G., 23672.
Astrand, I., 23844.
Astrozhnikov, IU. V., 22731.
Atkinson, R. L., 22599.
Atkinson, W. S., 22532.
Attissot, M., 22415.
Audier, M., 22360.
Auriol, M., 23903.
Ausherman, H. M., 23845.
Austin, G. H., 24356.
Australia. Commonwealth. Bureau of Census and Statistics, 22784.
Austria. Statistisches Zentralamt, 23344, 23345, 23469, 23626.
Avogaro, P., 22342.
Avundzhjan, E. S., 24337.
Ayd, F. J., Jr., 24051.
Azzolini, G., 22343, 22387, 22462, 24478.

**B**

Bab, W., 22533.
Babcock, C. I., 24015.
Babcock, M. J., 24429.
Baccari, V., 23670.
Baccarini, V., 23970.
Bachra, B. N., 24533.
Bachrach, U., 23634.
Badalotti, G., 23149.
Baehrel, R., 23005.
Bagabaldo, Z. B., 24558.
Bagaeva, V. T., 24574.
Bagnati, E. P., 24117.
Bagot, A. E., 24422.
Bailey, W. H., 24089.
Bain, C. W. C., 23737.
Baird, D., 23668.
Bak, L., 23346.
Baker, B., Jr., 23763, 23774, 24500.
Baker, B. M., 23092.
Baker, J. R., 22237.
Bakst, H. J., 22929.
Balduzzi, E., 22674.
Balfour, W. M., 24580.
Ball, R. M., 23476.
Ballow, J. E., 23846.
Baló, J., 23107.
Baluev, S., 23178.
Balvers, A. G., 23993.
Bandera, B., 22732.
Banga, I., 23096, 23107.
Bangham, D. R., 23792.
Baranov, V. G., 24052.
Baranyai, P., 22502.
Barasa, A., 24616.
Barbaruk, G. W., 23713.
Barbato, R., 22330, 23051.
Barbieri, E., 24487, 24488.
Barbieri, G., 23648.
Barboni, F., 23154, 24478.
Baretto, M. A., 23143.
Barfield, W. E., 23764.
Barker, A., 23068.
Barker, N. W., 24550.
Barnes, R. H., 23155.
Barnett, H. A. R., 23627.
Barnicot, N. A., 24611.
Barniske, R., 23979.
Baró Seguí, J. 23048.
Barrows, C. H., Jr., 23019.
Barry, M. C., 24818.
Barsa, J.A., 23279.
Barshop, I., 22822.
Barton, J., 22622.
Bas Figueroa, C. A., 22373.
Bassett, S. H., 23662.
Bateman, A. J., 23587.
Batson, H. M., Jr., 23063.
Baumann, C. A., 23643.
Baumann, J., 22559.
Baumgartner, L., 22726.
Baumgartner, P., 22586, 24603.
Baumgartner, W., 22733.
Bava, F., 24283.
Bayne, J. R., 23238.
Beach E. F., 22388.
Beaconsfield, P., 24720.
Beard, D., 24552, 24561.
Beard, J. W., 24552, 24561.
Beattie, J. W., 24647.
Beatty, R. P., 23531.
Beaudreau, G. S., 24552.
Becherelie, M. S. B., 24412.
Becker, F., 22734.
Becker, Th., 23793, 24118.
Becker, W. H., 22735.
Beckman, R. O., 22823, 22939.
Beckmann, G., 23920.
Becks, H., 23967.
Bedford, P. D., 23156.
Bedoya, J. M., 22389.
Beem, J. R., 24467.
Behrend, G., 22361.
Bélanger, C , 24535.
Belik, IA. V., 22473.
Belisle, J. A., 22675.
Bellin, S. S., 24053.
Bellini, E., 23079.
Belloc, N. B., 23268.
Bellotti, R., 22418.
Belluschi, P., 22866.
Belmont, I., 24044.
Below, F., 23347.
Belozerskii, A. N., 22252, 23606.
Belvin, E., 24722.
Bendell, J. F., 24357.
Bender, I. E., 24723.
Bender, L. F., 22585.
Benedetti, C., 24819.
Benjamin, B., 22259, 22785.
Benner, R. W., 24202.
Bennett, G. K., 23316.
Bennett, H. D., 24514.
Benney, M., 23317.
Benoni, W., 23649.
Ben-Shushan, D., 23145.
Bentor, V., 23180.
Bercovitz, Z. T., 23135.
Beresford, O. D., 24599.
Berg, B. N., 22238.
Berg, F., 23496.
Berggren, A., 24794, 24795.
Bergman, A., 22482.
Bergmann, D. E., 24358.
Bergqvist, S., 23902.
Berk, N. G., 23650.
Berke, M., 23292.
Berlatsky, M., 24016.
Berlin, S. O., 23902.
Berman, H. J., 24464.
Berman, J. H., 22909.
Bernard, M., 24603.
Bernhard, W. G., 23088.
Berres, H. H., 22589.
Berry, R. J., 22324.
Bertelsen, A., 24617.
Bertha, H., 24135.
Bertone, A. E., 22435.
Bertozzi, E., 24766.
Bertrand, P., 24714.
Bettag, O. L., 24683.
Beyda, E., 23741.
Bhasker, S. N., 23213.
Bick, E. M., 24618.
Bienstock, I. G., 23430
Bifani, I., 24119.
Biggers, B., 22940.
Biquet, J., 23847.
Bimes, C., 23108.



Published on a grant from the Forest Park Foundation to the Journal of Gerontology.

Bini, V., 22888, 23431, **24652**, 24796.
Birchall, R., 23063.
Birren, J. E., 24308.
Birtch, P. K., 23126.
Blache, J. O., 23094.
Black, K. O., 23109.
Blackman, L. H., 24054, 24684.
Blagosklonnaia, Ia. V., 22390.
Bláha, F., 23588.
Blanc, R., 23348.
Blanco Cancino, R., 23197.
Blanco-Soler, C., 22591.
Blanco-Soler, Y., 22391.
Blanke, K., 22736.
Blasingame, F. J., 23532.
Blatt, M. H. G., 23773.
Blau, M., 24414.
Blau, Z. S., 22889.
Bledsoe, C. W., 23198.
Bloch, H. I., 24838.
Bloch, S., 22392, 23597.
Block, L. N., 23675, 23823.
Blocker, C. E., 24767.
Blodi, F. C., 23921.
Bloomberg, B. M., 24454.
Bloomberg, W., Jr., 23407.
Bluestone, E. M., 22187, 22610, 22623, 22676.
Bluestone, S. S., 22638.
Blumenthal, H. T., 24588.
Bobochodzhaev, M. Ch., 24455.
Bockel, P., 23533.
Bocquet, L., 22517.
Bodart, A., 24619.
Bodian, M., 22534.
Bogdanski, K., 23142.
Boger, J., 23136.
Bohlmann, A., 22436.
Bokuniaeva, A. I., 22535.
Boland, E. W., 23975.
Boles-Carenini, B., 23199.
Boll, C. D., 22244.
Bolt, W., 22742, 23738, 24127.
Bonar, R. A., 24552.
Bonati, B., 23651, 23765.
Bonazzi, R., 22867, 23432, 24837.
Bond, E. D., 23534, 24113.
Bond, L., 23026.
Bondareff, W., 22382, 22463.
Boné, E. L., 24553.
Bonessa, C., 22393.
Bonhomme, H., 22670.
Bonnardel, R., 23318.
Bonner, C. D., 23766.
Bonnet, I., 22536.
Bonnet, P., 22536.
Bonomo, L., 23064.
Boone, A. W., 24640.
Booth, E. M., 24839.
Boretti, L., 24391, 24392.
Bornemann, K., 23750.
Bornemeier, W. C., 22910.
Bornet, V. D., 22890.
Borth, R., 22394.
Bortz, E. L., 22188, 22317, **23535**.
Bortz, W., 22344.
Borum, K., 24055.
Bose, A., 24169.
Bosina, E., 22523.
Botella Llusia, J., 23110.
Botwinick, J., 24724.
Boucek, R. J., 23097, 24489.
Bourlière, F., 22189, 22286, 22750, 23536, 24604.
Bourne, G. H., 22213, **22215**, 22287.
Boustedt, B., 24795.
Bowen, H. F., 23027.
Bowers, R. E., 23980.
Bowes, A. D. P., 22298.
Bowles, G. K., **23349**.
Bowman, K. M., **24003**.
Bowring, J. R., 24170.
Boyce, V. S., 22538.
Boyd, L. J., 22334.
Boyden, A. M., 24496.
Bracci, U., 23994.
Bradess, V. A., 22376.
Bradley, R. L., 23794.
Bradshaw, H. L., 23319.
Bradshaw, P. J., 22388.
Braham, J. E., 24426.
Brainerd, C. P., 23374.
Branch, C. H. H., 24004.
Brandéis, —., 23891.
Brandenburg, R. O., 23714.
Brandstrup, N., 23023.
Braun, H. W., 23324, 23335.
Braun-Falco, O., 22590.
Bravo, G. J., 22464, 23827.
Breckinridge, E., 22537.
Bredahl, E., 23111.
Breitenbach, J., 23033.
Breslow, L., 23848.
Bretey, J., 24601.
Breuer, J., 24042.
Brewster, A. W., 22880.
Bricker, E. M., 22710.
Bridges, J. F., 23885.
Bridgforth, E., 24426.
Brightman, I. J., 22640.
Brinley, J. F., 24724.
Brion, S., 22467.
Broda, E., 24349.
Bronsky, D., 23050.
Bronson, D. C., 24778.
Bronts, H. J., 24017.
Brook, D. L., 24520.
Brooke, M. M., 24554.
Browe, J., 22308.
Browman, L. G., 23771.
Brown, F. R., 24653.
Brown, G. N., 23137.
Brown, J. R., 22624.
Brown, L. B., 23350.
Brown, N. H., 23764.
Brown, P. C., 23758.
Brown, P. E., 23244.
Brown, R., 23103.
Brown, R. G., 23065, **23589**, 23739, 24056, 24057.
Brown, R. K., 24456.
Brown, R. W. B., 24465.
Brožek, J., 22329, 24309.
Brugger, M. H., 24102.
Brull, L., 22868.
Brummer, P., 22362.
Brunner, J. A., 22821.
Bruwer, A. J., 23714.
Bruyninckx, E., 24058.
Buchholz, H. U., 22395.
Buck, C., 23341.
Buechley, R. W., 23848.
Bühlmann, A., 22522.
Buell, Bradley & Associates, 22930.
Bürger, M., 23715, 24444, 24612.
Bugel, H. J., 22625.
Bulankin, I. N., 22973, 23635.
Bulkeley, K. H., 22626.
Bunch, L. D., 24459.
Bungart, K., 22220.
Buonomo La Rossa, B., 24120.
Burch, G. E., 23080.
Burgess, E. W., 22786, **23470**, 24136, 24275.
Burgoon, C. F., Jr., 24629.
Burgoon, J. S., 24629.
Burkard, W., 22454.
Burke, R. M., 22627.
Burke, W. T., 23061.
Burlina, A., 22320.
Burma. Census Division, **23351**.
Burnett, G. F., 24359.
Burney, L. E., 22952.
Burnight, R. G., 23352.
Burrill, L. M., 22296, **22299**, 22300.
Burrows, A. H., **23497**.
Burton, L., 23598.
Busch, G., 23028.
Busse, E. W., 23155, 23307, 24725.
Butt, E. M., 22359.
Button, D. E., 24779.
Buzina, R., 22329.
Buzzati-Traverso, A. A., 22787.

C

Cabot, H., 24310.
Cady, L. D., 22628.
Caffin, S. W., 22253.
Caldonazzo, C., 22345.
California. Department of Public Health. California Health Survey, 24103.
Caligaris, F., 23150.
Caliver, A., 22862, 22863.
Callaway, S., 23049.
Callender, S. T., 24448.
Calvel, V., 22570.
Calvi, L. A., 24605.
Camacho, D., 22398.
Cambiaggi, A., 23199.
Cameron, C. M., Jr., 22629.
Cameron, D. E., 24685.
Cameron, L. M., 22530.
Caminiti, F., 23767.
Campatelli, V., 23795.
Campione, G., 22396.
Campos, A., 22373.
Canada. Department of Labour. Women's Bureau, 23408.
Canada. Department of National Health and Welfare. Research and Statistics Division, 24104.
Canada. Dominion Bureau of Statistics, 22788, 23353, 23354, 23355.
Canada. Dominion Bureau of Statistics and the Department of National Health and Welfare, 23280.
Canada. Dominion Bureau of Statistics. Health and Welfare Division, 23006.
Canada. Royal Commission on Canada's Economic Prospects, 22789.
Canada. Welfare Council of Greater Winnipeg, 22891.
Canitano, P., 24555.
Cannon, J. A., 22221.
Cantegril, A., 23187.
Cantegril, E., 23187.
Cantore, B., 22518.
Caparó, A. C., 23685.
Cappelletti, G. A., 23060.
Capron, A., 23847.
Capuani, G. F., 22363.
Cardona, F., 23825.
Carey, G. C. R., 23196.
Carinci, M. P., 23212.
Carles, J., 24328.
Carlotti, G., 24797.
Carlson, L. D., 22483.
Carroll, G., 22604.
Carson, J. E., 22675.
Carter, F. R. N., 24554.
Carter, S. B., 23796.
Carton, M., 23187.
Casarett, G. W., 22484.
Casassa, P. M., 22321, 24556.
Case, T. C., 24515.
Casey, J. F., 24059.
Castellani, A., 23686, 23740.
Cavalieri, U., 22190, **22953**, 22954, 23537, 24018, 24137.
Cellier, C., 23923.
Cenacchi, G., 22674.
Cendron, H., 24604.
Centamori, M., 23692.
Cerrato, G., 22321.
Ceylon. Department of Census and Statistics, **24171**.
Chafetz, M. E., 24538.
Chalke, H. D., 23281, 23922.
Chambliss, R., 22905.
Chandler, B. J., 24780.
Chapman, C. B., 23874.
Chapman, H. W., 23576.
Chapman, L. E., 23538.
Chaproniere, D. M., 23849.
Charipper, H. A., 23539.
Charron, K. C., 24060.
Chaskin, W. W., 23639.
Chassaigne, —., 24503.
Chassaing, J., 23923.
Chen, E., 24061.
Chernekhovskaia, M. D., 22402.
Cherniak, A. Z., 22465.
Chernish, S. M., 23652.
Chesrow, E. J., 22519, 23050.
Cheung, M. W., 23020.
Chhuttani, P. N., 23826.
Chicago. Council of State Governments, 24296.
Chicago. Institute of Medicine. Central Service for the Chronically Ill, 22630.
Chicago. Jewish Federation. Drexel Home, Inc., 24798, 24840.
Chicago. National Dairy Council, 22941.
Chicago. Senior Achievement, Inc., 24768.
Chicago. Welfare Council, 22892.
Chicago. Welfare Council. Mayor Daley's Commission on Senior Citizens, 22893.
Chieri, S., 23687.
Chiga, D. E., 24251.
Chikwatia, W. R., 23632.
Chiquet, A., 23285.
Chomette, G., 23903.
Chope, H. D., 24297.
Chow, B. F., 23019, **24431**.
Chown, S. M., 23498.
Christian, D., 23302.
Christiani, H., 23578.
Christie, R. W., 24415.
Chu, J., 22531.
Church, H. N., 24429.
Chvapil, M., 22974, 24329, **24330**.
Cianci, S., 24589, 24590.
Cibelli, S., 24441.
Clancy, J. B., 24655.
Claringbold, P. J., 23887.
Clark, F. Le G., 22191, 22824, 24203, 24298.
Clarke, K. U., 22239.
Class, I., 22357.
Clément, F., 22750.
Clements, E. M. B., 23850.
Clemmer, D. I., 23885.
Clemmesen, J., 24062.
Cleveland. Benjamin Rose Hospital Staff, 24686.
Cleveland. Golden Age Center. Camp Committee, 24299.
Cleveland. Highland View Hospital, Department of Physical Medicine and Rehabilitation, 24019.
Cleveland. Welfare Federation. Occupational Planning Committe, 22847.
Close, M. B., 22737.
Coale, A. J., 23356.
Coassin, N. A., 22322.
Cobb, S., 24061.
Coerper, C., 22955.
Coetzee, J. C., 22192.
Coffman, F. A., **24331**.
Coggins, R. P., 22666.
Cogni, G., 24122.
Cohen, J., 22751, 23320.
Cohen, W., 24063.

Cohen, W. J., 24252, 24253, 24261, 24284, 24285.
Cohn, R., 22737.
Cole, H., Jr., 24332.
Coleman, L. I. M., 22693.
Collins, S. D., 23446.
Collins, V. J., 23851.
Collins-Williams, C., 24557.
Colmart, C., 22681.
Colombo, U. M., 22879, 22894.
Coltorti, M., 22289.
Combs, J. W., Jr., 24772.
Comfort, A., 22240, 23599.
Commission on Chronic Illness, 22677, 23282.
Commons, R. R., 23113.
Conestabile, E., 23970.
Conley, J. J., 24064.
Connell, M. R. E., 24373.
Consden, R., 23758.
Consolini, M., 23740.
Convit, J., 24600.
Conway, J., 23066.
Coodley, E., 24516.
Cook, E. N., 23995.
Cooke, A., 23540.
Coons, D. H., 24841.
Cooper, C. F., 23109.
Cooper, I. S., 22464, 23827.
Cooper, P., 24520.
Copaira, M., 23685.
Coppo, M., 23653, 23765.
Corà, D., 22342.
Coraggio, F., 23924.
Corbett, J. J., 23600.
Corcoran, A. C., 23073.
Cordero, N., 24558.
Cordrey, L. J., 23852.
Corey, L. G., 24136.
Cork, J. M., 23601.
Coronelli, M., 23985.
Cortesi, C., 23925.
Cosin, L. Z., 24254, 24687.
Costa Rica. Dirección General de Estadística y Censos, 22273.
Couper, L., 22691.
Court-Brown, W. M., 24559.
Covell, W. P., 23938.
Cowdry, E. V., 23541.
Coyne, E. P., 24677.
Coyne, N, 23245.
Craig, F. N., 23855.
Crane, H. R., 24311.
Crasilneck, H. B., 22752.
Craver, W. L., 23081.
Creevy, C. D., 22600.
Cremerius, J., 23768.
Cresti, M., 22330, 23051.
Cristiani, G., 22746.
Critchley, M., 24138.
Cronin, M. T. I., 24473.
Crook, M. N., 24139.
Crow, J. F., 22225.
Crowell, S, 22241.
Crowther, B., 23451.
Cruikshank, N. H., 24105.
Cullimore, O. S., 22388.
Culp, O. S., 22604.
Cumper, G. E., 23357.
Cunat, J. J., 23213.
Cunningham, N. F., 24435.
Cuny, G., 23721.
Curtis, H. J., 24560.
Cynberg, M., 22877.
Cyprus. Financial Secretary's Office. Statistics Section, 23358, 23359.
Czechoslovakia. Státní Urad Statistický, 22274, 22275

D

Dacso, M. M., 23239, 23246, 23263.
Dahl, L. K., 24415.
Dahl, N. A., 24580.
Dahlström, H., 22632.
Dalfino, G., 23133.
Dalgaard, J. B., 24517.
Dall'Acqua, G. F., 24393.
Danilkovich, E. M., 24360.
Darby, W. J., 23660.
Daric, J., 22753, 22825.
Darlington, C. G., 23137.
Darsania, J. M., 23632.
Daudén Sala, C., 23981.
Daugherty, A. E., 24364.
Davenport, D. M., 24568.
Davéo, J. P., 23891.
Davey, W. W., 24715.
Davidheiser, R. H., 23226.
Davidson, L. A. G., 23739.
Davidson, N. W., 23827.
Davies, D. R., 23049.
Davies, E. J., 22466.
Davies, L., 24361.
Davis, H., 23938.
Davis, J. B., 22608.
Day, L. H., 24591.
De Anquín, C. E., 22565.
Deblock, S., 23847.
De Bonis, G., 23976.
Decio, C., 23769.
Dedichen, H. G., 22364.
De Franciscis, P., 22331.
de Gironcoli, F., 22601.
De Giuli, G., 23853.
Dehnel, P. A., 23854.
Delagi, E. F., 23255.
DeLalla, L., 24456.
de Lapouge, G., 24740.
Delarue, J., 23903.
de la Vega, E., 23685.
Delay, J., 22467.
Del Bello, N., 24120.
Del Greco, V., 22678.
Della Maggiore, U., 22411.
Delore, P., 22226, 22956, 23456.
Delsol, J., 22637.
De Marchi, R., 23705.
Demény, E., 23617.
Denbotough, M. A., 24448.
Dening, K., 24091.
Denko, C. W., 22485.
Denmark. National Morbidity Survey, 23283.
Denmark. Statistiske Department, 22790, 22791, 23628, 24172.
Dennis, D., 24565.
Dennis, E. W., 24597.
Dent, J. N., 24502.
Dent, R. W., 22754.
DePalma, A. F., 23214.
De Palma, C., 22387.
De Pinho, L. G., 22831.
Deringer, M. K., 23896.
Derjabina, G. I., 24539.
Derrick, J. R., 23067.
de Ruiter, L., 24362.
Desmond, T. C., 22193, 23499, 24312.
Destrem, H., 23240, 23972.
Detlefsen, M., 23112.
De Toni, E., Jr., 22560.
Deuel, H. J., Jr., 22295.
de Vergottini, M., 23360.
Devoe, D. M., 24139.
Dewhurst, J. R., 23922.
DeWind, L. T., 23113.
DiCicco, L., 24688.
Dickie, M. M., 24434.
Dickinson, F. G., 24276.
Dickson, I. A., 24065.
Diekmeier, L., 23542.
Di Giulio, V. S., 23665.
Dill, D. B., 23409, 23855.
Di Macco, G., 22486.
Di Martíno, G., 24119.
Dixon, A. D., 22975.
Dju, M. Y., 23654.
Doberauer, W., 22437, 23052, 23247, 23308.
Dobson, H. L., 23770.
Dobzhansky, T., 22227.
Docimo, C., 23154.
Doctor, R. H., 23143.
Dodge, H. J., 24689.
Dodson, J. E., 22506.
Dömök, I., 22487.
Dolfini, G., 23543.
Doll, R., 22228, 23278.
Domareva, O. P., 23856.
Domke, H. R., 23248.
Donahue, W., 24262.
Donahue, W. T., 22948, 22949, 22957, 22958, 24841.
Doniach, I., 24530.
Donnes, A. V., 23833, 24615.
Donzelot, E., 23741.
Dorken, H., 24140.
Dorn, W., 23215.
Dorsey, F. G., 23488.
Dothée, L., 22566.
Drahota, Z., 23818.
Drake, J. T., 23457.
Drake, R. M., 23848.
Dransfeld, B., 23857.
Draper, H. H., 23034, 24430.
Dreyer, J. J., 23858.
Droller, H., 24839.
Druzhinina, K. W., 23789.
Dubarry, J. J., 23797.
Dubin, A., 23050.
Dubose, H. M., 22528.
Dubrovizkaja, N. I., 23574.
Duff, J. C., 24263.
Dufficy, R. G., Jr., 23249.
Duffy, M. L., 23977.
Duke University, 22194.
Dun, G. B., 23099.
Dunbar, F., 23241.
Dunn, H. L., 23309
Dunn, J. E., Jr., 24690.
Dunn, T. B., 23896.
Dunton, F., 22358.
Durell, A. M., 22459.
Dury, A., 23716.
Dustan, H. P., 23073.
Dybkaer, R., 23676.
Dyke, R. W., 22365.
Dyniewicz, H., 23050.
Dyrbye, M., 23717.

E

East African High Commission. Statistical Department, 24173, 24174.
Easterlin, R. A., 23374
Eastman, A. A., 24607.
Ebert, H., 23742.
Ebert, R. V., 24602.
Eckelmann, W. R., 22494, 23165.
Eckert, E. A., 24561.
Ecudador. Junta Nacional de Planificación y Coordinación Económica, 24175.
Edozien, J. C., 23053.
Egener, K. M., 23341.
Eguchi, M., 24450, 24563.
Eichwald, E. J., 24583.
Eisen, S. B., 24281.
Eisentraut, A. M., 22326.
Ekholm, R., 22579.
Ektov, V. A., 23819.
Elden, H. R., 23097, 24489.
Elder, J. H., 24744.
Eldersveld, S. J., 24277.
Eldredge, D. H., 23938.
Elias, H. F., 24121.
Elkeles, A., 23718.
Ellenbogen, L., 24431.
Ellicott, V. L., 24021.
Ellis, R. A., 24630.
Elman, R., 23026.
Elster, K., 22440.
Emel 'yanov, A. N., 23673.
Emezson, A. R., 23489.
Emmers, R., 24548.
Empel, W., 24613.
Ende, M., 22602.
Eng, R. L., 24363.
Engelberg, H., 24457.
Engelhardt, H. T., 23770.
Epstein, J. A., 23773.
Epstein, L. A., 23401.
Ercoli, E., 23432.
Erickson, R., 23284.
Eriksson, A., 23250.
Erk, V. O., 22422.
Ermiglia, G., 23114.
Ernst, J. P. D., 22397.
Ernstene, A. C., 23095.
Ernster, B., 24416.
Ernster, L., 24416.
Erwin, H. J., 22633.
Escourolle, R., 22467.
Esselbaugh, N. C., 23966.
Estève, J., 23285.
Eszéki, J., 23752.
Evans, F. T., 23166.
Evans, H. M., 23967.
Evans, L. S., 24654.
Everitt, A. V., 22242, 22243, 22332, 24417, 24432, 24449, 24479.
Exton-Smith, A. N., 24005, 24006.
Ezzo, J. A., 23077.

F

Fabi, M., 22346.
Fabry, P., 23037.
Fadeuilhe, A., 22671.
Fagerberg, E., 23859.
Failla, G., 22488.
Fajgelbaum, M., 22482.
Falek, A., 24143.
Falk, G., 22762.
Falk, I. S., 22880.
Fanucchi, F., 22679.
Farman, C. H., 22911, 23477.
Fattovich, G., 22680.
Faurre, L. E., 22475.
Fautrel, M., 23605.
Fayolle, J., 24518.
Fazzari, I., 23575.
Federal Housing Administration, 24799, 24800, 24801, 24802, 24803, 24804.
Federal Housing Administration. Division of Research and Statistics, 24805.
Federal Housing Administration. Housing and Home Finance Agency, 24806, 24807.
Fein, S. B., 24528.
Feinblatt, H. M., 23167, 24641.
Feldman, D., 24648.
Feldman, H. S., 24655.
Feldstein, M., 22545, 22553.
Felin, F. E., 24364.
Fergus, C. L., 24332.
Ferguson, E. B., 22959.
Ferguson, T., 22634.
Ferguson Anderson, W., 24022.
Fernoux, H., 24529, 24714.
Ferond, M., 22580.
Ferrer, M. ., 23852.
Ferris, B. G., Jr., 23189.
Fery, N., 22520.
Feudell, P., 22755.
Feuillet, C., 22681.
Ficarra, B. J., 23312, 24497.
Fieandt, G., 23321.
Figge, F. H. J., 23226.
Filer, L. J., Jr., 23654.
Filippova, T. A., 23636.
Fincato, M., 24122.
Fincham, E. F., 24606.
Fink, H. H., 22756.

Finland. Tilastollinen Päätoimisto, 23007, 23361.
Finsbury Health Center, 24769.
Finzi, A., 24605.
Fisch, C., 22365, 22635.
Fischer, F. W., 22333, 23688.
Fishman, W. H., 23766.
Fitzgerald, J. F., Jr., 22195.
Fitzgerald, W. T., 23077.
Flament, J., 23828.
Flannery, W. E., 22438.
Fleischmann, O., 24537.
Fleming, C., 22826.
Flemming, C., 23216.
Flint, F. J., 23188.
Flocks, R. H., 22604.
Flury, E., 22392.
Flyger, G., 23157.
Fogel, E. J., 22195.
Fog-Poulsen, M., 22521.
Foix, A., 22398.
Fokina, T. B., 24562.
Fongi, E., 22439.
Fontana, P. F., 22396.
Foote, F. M., 22538.
Foote, R. E., 22636.
Forbes, R. M., 23656.
Ford, A. B., 23852.
Ford, D. H., 23892
Forgács, P., 22539.
Forgash, A. J., 24365.
Forsius, H., 23200.
Foskett, D. R., 24366.
Fouts, P. J., 23652.
Fowler, D. I., 23020.
Fowler, J. H., 24023.
Fox, C. L., Jr., 22714.
Fox, J., 23286.
Fraccaro, M., 23042.
Fraenkel, M., 23287.
France. Institut National de la Statistique et des Études Economiques, 23008.
France. Institut National d'Études Demographiques, 22960.
France. Ministère de la France d'Outre-Mer. Service des Statistiques. Territoire du Sénégal. Territoire de la Mauritanie, 24176.
France. Ministère des Affaires Economiques et Financières. Commissariat Général au Plan. Service des Etudes Economiques et Financières, 22792.
Franchini, A., 24123.
Francis, T., Jr., 24568.
Françon, F., 22366.
Frank, N. R., 23189.
Frank, P. W., 22244.
Franken, F. H., 23056.
Franklin, S., 24249.
Frassineti, A., 23235.
Frazier, L., 22869.
Fredrikson, H., 22507.
Freedberg, A. S., 23674.
Freeman, G. L., 23322, 24726.
Freeman, J. T., 23151.
French West Africa. Gouvernement Général. Mission d'Étude de l'Ouémé, 24177.
Freudenberg, K., 22229, 22254.
Freund, K., 22682.
Freydberg-Lucas, V., 22288, 24493.
Friedberg, C. K., 23095.
Friedberg, R., 24066, 24480.
Friedel, W., 23052.
Friedlander, W. J., 23158.
Friedman, A. I., 22399.
Friedman, C. L., 24468.
Friedman, E. L., 23155.
Friedman, G. A., 22895.
Friedman, M., 22301.
Friedman, S. M., 24468.
Frings, J., 23115.
Frisch, A., 23904.
Fry, J., 23447.
Frye, W. W., 24554.
Fuchs, M., 23709.
Fuentes, G. A., 22738.
Fujisaku, S., 22987.
Fuller, C. A., 24440.
Fulton, G. P., 24464.
Fulton, L. A., 23068.
Furman, R. H., 24458.
Furuhata, T., 24450, 24563.

## G

Gaab, J. E., 24379.
Gabay, S., 23991, 24638.
Gabriel, J., 22988.
Gadek, R. J., 23260
Gafafer, W. M., 23410.
Gagliardi, R. A., 22561.
Gaini, B., 23082.
Galbraith, J. G., 23160.
Gallego Capilla, J., 23629.
Gallini, R., 23082.
Gambescia, J. M., 24531.
Gambirasio, C., 23913.
Gant, J. C., 24641.
Garcia, J. F., 22323.
Garcia Herrera, E., 24691.
Gardin, F., 22490, 23190.
Gardiner, J. L., 24564.
Gardner, W. J., 24024.
Garello, L., 23083.
Garn, S. M., 23168.
Garner, H. H., 24656.
Gasset, M. A., 23448.
Gates, L. O., 24429.
Gatto, E., 23083.
Gauld, R. L., 24689.
Gause, R. W., 23893.
Gavrilov, N. I., 23607.
Gaymont, S., 23040.
Gebhart, A. F., Jr., 23644.
Gebhart, D. L., 22869.
Gecht, A., 24124.
Geckeler, G. D., 23747.
Geill, T., 22340, 22827, 23544.
Gelbach, P. D., 22561.
Gellhorn, E., 23176.
Gengozian, N., 23169.
Genovese, P. D., 22365.
Gentin, F., 24619.
Gerber, M., 22540.
Gere, G., 23602.
Gerfeldt, E., 24692.
Gerking, S. D., 22985.
Germany. Berlin (West). Statistisches Landesamt, 22793.
Germany. Federal Republic. Statistisches Bundesamt, 22276, 22277, 22278, 22794, 22795, 22906, 23362, 23363.
(The) Gerontological Association of Japan, 24313.
Gerontological Society, Incorporated, 22196.
Gershon-Cohen, J., 22421.
Gertz, B., 23323.
Geschwind, H., 24178, 24217.
Gherardi, A., 22302.
Ghurye, G. S., 24264.
Giachetti, A., 23669.
Gianotti, F., 23985.
Gibson, J. H., 22594.
Giese, H., 24727.
Gilardi, A., 24713.
Gillett, J. D., 22245.
Gilliam, A. G., 24073, 24403.
Gillies, M. T., 24367.
Gillot, P., 23719.
Gilmore, H. R., 24461.
Gingrich, W. D., 23545.
Giotti, A., 23860, 24657.
Girard, M., 24518.
Girolami, M., 23798.
Gist, N. P., 23364.
Gitman, L., 22689, 23219.
Gittelsohn, A., 24699.
Giusti, G., 22289.
Gladis, M., 23324.
Glancy, K. E., 24792.
Glanzer, M., 24728.
Glaser, R., 24728.
Glass, B., 23325.
Glatt, M. M., 24114.
Glenn, A., 24054, 24684.
Glenn, F., 23081.
Gobetto, A., 24616.
Godin, G., 24179.
Goetsch, W., 22961.
Gold, R. Z., 24593.
Goldberg, G. M., 23842.
Goldbloom, A. A., 22334.
Golden, L., 23080.
Goldfarb, A. I., 22683, 24144, 24156.
Goldin, A., 24565.
Goldman, D., 24051.
Goldman, I. B., 24125, 24126.
Goldner, M. G., 23142.
Goldschmidt, L., 23689.
Goldzieher, J. W., 24498.
Golin, M., 23500.
Golob, M., 23217.
Golubizka, R. L., 23803, 23823.
Goluboff, B., 23835.
Gómez, D. F., 22439.
Gomez, F., 23934.
Good, H. M., 24340.
Good, M. G., 22541.
Goode, E. R., Jr., 22489.
Goodhope, C. D., 22603.
Goodman, J. I., 24433.
Gordon, C., 23489.
Gordon, E. E., 22638, 23861.
Gordon, M. W., 24333.
Gore, I., 24475.
Gorek, E. A., 23827.
Goret, P., 23128.
Gorshunova, L. P., 24067.
Gossmann, H. H., 22567.
Gottschalk, L., 24163.
Goudriaan, J. C., 23567.
Gould, W. L., 22400.
Gowen, G. H., 22197.
Gowen, J. W., 23862.
Grab, B., 23170.
Graef, I., 22403.
Graf, K., 24466.
Graffi, A., 23863, 23864.
Grahn, D., 24566.
Gramberg, A., 22796.
Gramm, H., 22255, 24068.
Grand, H., 24016.
Grandjean, E., 22454.
Grant, A. P., 24712.
Gray, I., 22335.
Great Britain. Central Statistical Office, 23009.
Great Britain. East African Royal Commission, 23365.
Great Britain. General Register Office. England and Wales, 23010, 23011.
Great Britain. Ministry of Labour, 24204.
Greece. Genikē Statistike Hyperēsia, 22797.
Green, G., 24519.
Green, H., 22542.
Green, J., 23690.
Greenberg, D. M., 24422.
Greenberg, J., 24414.
Greenberg, S., 22942.
Greenblatt, R. B., 23894.
Greene, J. A., 23770.
Greening, S. G., 23099.
Greenland, C., 23895.
Gregory, I., 24439.
Grenier, R., 23366.
Grenoilleau, —., 22637.
Greppi, E., 22303, 22304, 22611, 22962, 23546, 23707, 24658.
Gretschishkin, D. K., 23952.
Greve, E., 22246.
Grice, H. C., 24373.
Grieser, K. C., 23771.
Griew, S., 22837, 24729, 24774.
Griffin, H. E., 24689.
Griffin, J. B., 24311.
Griffin, T. L., 23894.
Griffith, G. C., 22714.
Griffith, H. H., 22943.
Griffith, W. H., 23662.
Grimes, B. P., 22663.
Grisell, J. L., 22769.
Grmek, M. D., 22198.
Groen, J., 23547, 23567.
Groene, L. T., 22636.
Grossman, B., 22543.
Grote, L. R., 22318.
Gruen, A., 24730.
Gruenberg, E. M., 22708.
Grunt, J. A., 22324.
Grynbaum, B. B., 22638.
Gualtierotti, F., 22639.
Guera Miralles, A., 22757.
Guerrant, J. L., 23865.
Guidi, G., 22490, 23190, 23548, 23708, 24659.
Guilhem, A., 23108.
Guillitte, P., 22870.
Gupalo, P. J., 24334.
Gupta, K. K., 23057.
Gurtman, A. I., 23773.
Gurvich, A. E., 23691.
Gustafsson, L., 22460.
Guth, S. K., 23201, 24607.
Gutman, R., 23608.
Gutmann, A., 23818.

## H

Haar, H. O., 22422.
Haase, H. J., 22684, 23590.
Haberland, R., 24472.
Hadfield, R., 24581.
Haefliger, E., 24069.
Hageman, K. C., 24139.
Hagen, B., 24368.
Hager, G., 22544.
Haggard, E. B., 22912.
Haimovici, H., 24420.
Hajnal, J., 22881.
Hale, M. P., 23433.
Hall, C. E., 22325.
Hall, D. A., 23098.
Hall, O., 22325.
Hall, W. J., 23288.
Halleck, F. E., 24358.
Hallervorden, J., 24540.
Halliday, R., 23054.
Hamburger, C., 23116.
Hamburger, J., 22719.
Hamilton, J. B., 24459, 24631, 24632.
Hamilton, K. F., 24566.
Hammarsten, G., 23711.
Hammerl, H., 23720.
Hammons, P., 24677.
Hamolsky, M. W., 23674.
Hamtoft, H., 24066.
Hamwi, V., 22547.
Hand, B. M., 23829.
Handelman, M. S., 24656.
Handley, C. A., 23148.
Hanley, T. D., 24743.
Hansen, P. F., 23242.
Hanson, J. A., 24139.
Hardin, K. N., 23501
Hardt, R. H., 24053
Hardy, R. H., 24611.
Harkins, J. L., 23126.
Harkness, M. L. R., 22347.
Harkness, R. D., 22347.
Harmison, C. R., 22238.
Harnly, M. H., 23598.

Harris, C., 23061.
Harris, R., 23138, 23736, 24025.
Harrower, H. W., 24520.
Hart, G. R., 22944.
Hartman, T., 23012.
Hartmann, J., 24567.
Hartog, B. J. Den, 24007.
Harton, W. R., Jr., 22882.
Hartsfield, M., 22421.
Hartsook, E. W., 22305.
Hartwich, A., 23549.
Haskins, F. A., 23576.
Hatam, K., 22702.
Haurowitz, F., 24462.
Havemann, E., 23502.
Havighurst, R. J., 22896, 22931, 23458, 23459, 23550, 24731, 24820.
Hawkins, C. E., 22871.
Hayami, H., 23021.
Hays, F. A., 24592.
Hazlet, J. W., 22294, 23644.
Healey, D., 23503.
Healey, R., 24560.
Health Information Foundation, 22256.
Heath, O. V. S., 22216.
Hedges, S. G., 22932.
Hegemann, G., 22739.
Heider, C. H., 24085.
Heim de Balsac, R., 23741.
Heine, U. I., 24335.
Heinkel, K., 22440.
Heite, H. J., 23982.
Hejtmancik, M. R., 22369.
Hellbaum, A. A., 23778, 23977.
Heller, E. M., 22367.
Helmer, O. M., 23652.
Henderson, E., 23963.
Henn, H., 25702.
Henneman, P. H., 23964.
Hennessen, W., 23884.
Hennessy, V. A., 24568.
Henning, N., 22440.
Henripin, J., 23183.
Henry, I., 22681.
Henry, J. W., 23894.
Henry, K. M., 23035.
Henry, L., 22989.
Henshaw, P. S., 22319.
Herbert, G., 24660.
Herbeuval, R., 22368, 23721.
Herbst, M., 23750.
Herfort, R. A., 23222.
Hernández Gutiérrez, L., 23117.
Heron, A., 22758, 24205.
Herrmann, G. R., 22369.
Herrmann, U., 22401.
Hershberger, R. L., 24597.
Hersperger, W. G., 24026.
Hertault, J., 22416.
Herzberg, F., 23926.
Hess, A. E., 22913, 22914, 23478.
Hesse, F. E., 23268.
Hessert, R. B., 23335.
Heston, W. E., 23896.
Hevelke, G., 23722.
Heydenreich, A., 23927.
Higgins, C. C., 22604.
Higginson, J., 23805.
Higgons, R. A., 23033, 23683.
Hill, A. B., 22228.
Hilleboe, H. E., 22348, 22640, 23434.
Hilmy, S. A., 24594.
Hils, K., 23118.
Hilscher, W., 23908.
Himel, H. A., 23202.
Himes, M. B., 23141.
Himwich, H. E., 23303
Himwich, W. A., 23159.
Hindle, E., 23551.
Hinkel, C. L., 22441.
Hinshaw, D. B., 23809.
Hinshelwood, C. N., 22247.
Hirsch-Weber, W., 24278.
Hjelmquist, U., 23157.
Hobbs, G. E., 23341.
Hoberman, M., 22640.
Hobson, W., 22641, 22828, 22963, 23411.
Hochbaum, G. M., 24693.
Hochheimer, W., 22349.
Hochrein, M., 22725.
Hodges J. L., Jr., 23698.
Hoerr, S. O., 22740.
Hoffman, E., 23799.
Hoffman, J., 23141.
Hoffman, M. M., 23788.
Hofmann, E. C. G., 23637.
Hoffmann, V., 22741, 22742, 24127.
Hoge, E. B., 23490.
Holden, J. B., 22863.
Hollandbeck, R., 23763, 23774, 24499, 24500.
Hollander, J. L., 22581.
Holle, H. A., 23310.
Holliday, M. A., 22459.
Hollingsworth, T. H., 23367.
Hollister, A. C., Jr., 24699.
Holmes, E. M., Jr., 22882.
Holmes, T. H., 24504
Holmgren, I., 23723, 23724.
Holubář, J., 23171, 23172.
Holzer, M., 24128.
Homburger, F., 22642, 23251, 23766.
Honegger, H., 22848.
Honton, —., 24503.
Hood, B., 23047.
Hopkins, E. H., 22964.
Hopkins, T. S., 23775
Hoppert, C. A., 24532.
Horbach, L., 23609.
Horbaczewski, J., 24070
Hormia, A., 24141.
Horn, G., 22442.
Horn, J., 23905.
Horner, A. A., 24519.
Horst, P., 22778.
Horvath, S. M., 23855.
Horwitt, M. K., 23036.
Hotta, T., 24406.
Hou, P. C., 23289.
Houck, J. C., 24633.
Howard, E., 22383.
Howard, E. B., 23479.
Howard, F. D., 24336.
Howard, J. M., 23067.
Howard, R. P., 24458.
Howard, W. M., 24781.
Howell, T. H., 23084, 23191, 23830, 24071, 24465, 24521, 24661.
Howland, W. S., 24132.
Hrabáně, J., 23697.
Hrůza, Z., 23027, 24330, 24418.
Huang, C. H., 24569.
Huber, K., 24494, 24495.
Hubička, E., 23996.
Huckins, D. S., 23303.
Hudec, A. J., 23174.
Hüfner, W., 22990.
Hügin, F., 22979.
Hügin, W., 23866.
Hüner, H., 23056.
Hürlimann, A., 23074.
Huet, J. A., 23435.
Huggett, A. J., 24782.
Hughes, J. D., 23412.
Huhtala, A., 23321.
Huisman, T. H. J., 23022.
Hummel, K. P., 24512.
Humphreys, S. R., 24565.
Hungerland, H., 24522.
Hunt, G. H., 22612.
Hunt, H. R., 24532.
Hunt, T. E., 22976.
Hunter, W. W., 24841.
Hursh, J. B., 23867.
Husain, A. F. A., 24180.
Huycke, E. J., 23552.
Hydén, H., 22977.
Hyman, H. H., 24831.

I

Idaho. Governor's Conference on Problems of Older Citizens, 22897.
Idenburg, P. J., 22279.
Ignatius, J. A., 24716.
Illari, G., 22336.
Illing, H. A., 24265.
Imagawa, R., 24458, 24459.
India. Kanara Saraswat Association. Census Working Committee, 23368.
India. Office of the Registrar General, 23369, 23370, 24206.
Indiana. State Commission on the Aging and Aged, 24106.
Indonesia. Institute for Economic and Social Research, 23371.
Indra, R. R., 23013.
Ingegnieros, S., 22498, 22679, 22685, 22686, 23290.
Ingelman-Sundberg, A., 22512.
Ingelmark, B. E., 22460.
Inglis, J., 22687, 24142.
Insolera, F., 22991.
Interdepartmental Committee on Older Workers, 24219.
International Association of Gerontology. Social Science Research Committee, 24314.
International Labour Office, 22829, 22830.
International Labour Organization, 22849.
Ireland. Central Statistics Office, 23630.
Irmisch, G. W., 24642.
Irvine, R. E., 22457.
Irwin, L., 22306.
Ishmael, W. K., 23977.
Isobe, S., 24411.
Israel. Central Bureau of Statistics, 22280, 22798.
Italy. Centro di Documentazione, 22799.
Ito, C., 23021.
Ivanov, I. I., 23820.
Iversen, E., 23906.
Iversen, S., 23800.
Iyer, P. V. K., 23057.
Izaki, M., 23227.

J

Jablon, S., 22272.
Jackson, B. H., 22483.
Jaco, E. G., 22721, 24095.
Jacob, R. A., 24633.
Jacobs, H. L., 23933.
Jacobs, W. M., 23129.
Jacobson, H. A., 24720.
Jacobson, P., 22602.
Jacot, C., 23074.
Jaffe, H. L., 24470.
Jahn, G., 23184.
Jamaica. Department of Statistics, 24181.
Janet, J., 23797.
Jansen, L. H., 23983.
Janzarik, W., 24694.
Japan. Bureau of Statistics, 23372.
Japan. Ministry of Health and Welfare, 24759.
Jarvik, L. F., 24143.
Jasny, N., 24182.
Jasper, W. S., Sr., 23814.
Jastak, J., 22781.
Javier, B. V., 24558.
Jelínek, J., 23953.
Jenkins, S. B., 22675.
Jensen, E., 24072.
Jensen, H. E., 24821.
Jensen, V., 24042.
Jessar, R. A., 22581.
Jiménez de Asua, F., 24451.
Joel, W., 23759.
Johansen, L., 22992.
Johansson, E., 22716.
Johnsen, S., 23116.
Johnson, D. E., 24107.
Johnson, F. G., 22688.
Johnson, F. R., 23577.
Johnson, W. M., 22613.
Jolles, B., 23099.
Jonáš, V., 24108.
Jones, C., 22675.
Jones, E. M., 23643.
Jones, H. B., 22667.
Jones, H. E., 24315, 24316.
Joos, H., 22522.
Jordan, A., 23055.
Joris, T., 22727.
Joseph, J., 23821.
Juhász, J., 23107.
Juliard, L., 23605.
Jung, A., 24717.

K

Kadlecová, V., 23928, 23929.
Kärki, N. T., 22453.
Kahn, R. L., 24144, 24156.
Kahnemann, F., 24634
Kaiser, R. F., 24073.
Kaldor, I., 22290.
Kallman, R. F., 23868, 24570.
Kallmann, F. J., 24143.
Kamholtz, T., 23219.
Kamitani, Y., 22291.
Kao, K.-Y. T., 23097, 24489.
Kapadia, P. N., 24377.
Kaplan, J., 22643, 22898, 23460, 24317.
Kapustina, E. V., 24541.
Karanovic, J., 23672.
Karimov, Z. K., 22491.
Karnbaum, S., 22350, 23725, 23726, 24469.
Karpinos, B. D., 22800.
Karsaevskaja, I. G., 23691.
Kasanen, A., 22362.
Kasavina, M. S., 23822.
Katchalsky, A., 23703.
Katinas, G. S., 24536.
Kauchtschischwili, G. M., 22492, 24695.
Kaufmann, W., 23087.
Kawada, S., 23030.
Kawamura, H., 24476.
Kazarjan, V. O., 24337.
Keaty, E. C., 24458.
Keech, M. K., 22591.
Keeler, K. C., 23223.
Kekwick, R. A., 23054.
Kelemen, G., 23801.
Kellam, C. E., 22934.
Kellat, G. A., 22402.
Keller, A. R., 22408.
Keller, R., 22454.
Kellgren, J. H., 23973.
Kelly, J. J., Jr., 24481.
Kelly, R. W., 22244.
Kendell, H. W., 22644.
Kendis, M. S., 22294.
Kennedy, G. C., 22307, 22455, 24145.
Kennedy, M., 24233.
Kent, E. A., 22689.
Kenter, H., 22469.
Kern, E., 23373.
Keutzer, A., 22223.
Kevesh, L. E., 23954.
Khaskin, V. V., 23024.
Kibadze, T. T., 24347.

Kiernander, B., 23252.
Killander, A., 23656.
Killick, S. R., 24369.
Kilpatrick, R. A., 24338.
Kim, Y. S., 24689.
Kim Bon Diun, —., 23930.
Kimmelstiel, P., 24000.
Kimura, A. M., 23640.
Kimura, Y., 23227.
Kindstrand, W., 22645, 23253.
King, J. C., 23085.
King, J. H., Jr., 23931, 23932.
Kinnaman, J., 22308.
Kinnunen, O., 22405.
Kinross-Wright, V., 24085.
Kinsell, L. W., 22403, 23638.
Kinsella, T. J., 23907.
Kirchner, W. K., 24146.
Kirk, J. E., 22351, 23023, 23717.
Kirk, T. E., 22624.
Kirkpatrick Memorial Programs on Gerontology, 22199.
Kiseleva, A. F., 23743.
Kiyono, K., 24476.
Kjerulf-Jensen, K., 24074.
Kjorstad, J., 23086.
Klaber, M. M., 24143.
Klarman, H. E., 24109.
Klauzer, J., 23631.
Kleemeier, R. W., 24110, 24266, 24732, 24733.
Klein, A., 23141.
Klein, E., 23056.
Klemme, H. L., 22646.
Kley, I. B., 24087.
Kline, D. L., 22322.
Kline, N. S., 23279, 24051.
Klopfer, W. G., 24734, 24735.
Klotzbücher, E., 24419.
Klumpp, T. G., 22493, 23311.
Knipping, H. W., 22742, 24127.
Knisely, W. H., 22324.
Knobloch, H., 23715, 23908, 24612.
Knudsen, K. J., 22690.
Knudson, A. B. C., 24027.
Knutson, H., 24354.
Koch, G., 23553.
Kodlin, D., 22965.
Köhler, U., 24028.
König, E., 24608.
König, H., 22743.
Koenigsfeld, H., 22230, 22231.
Kohlstaedt, K. G., 23652.
Kohn, H. I., 23868, 24570.
Kohn, R. R., 24490.
Kohout, M., 24571.
Kolbe, H. W., 22726.
Kolomeyer, N., 24029.
Kon, S. K., 23035.
Kooi, K. A., 24542.
Kooy, F. H., 23831.
Kopac, M. J., 23598.
Kornbluth, A. W., 24662.
Kornzweig, A. L., 22545, 22553.
Kortua, I. E., 23632.
Koshkina, T. V., 24370.
Kosse, K. H., 24075.
Kotôda, S., 24505.
Kotsovsky, D. A., 23554, 24649.
Koval, G. Yu., 23869.
Kraatz, H., 22508.
Krachko, L. L., 22473.
Krähenbühl, C., 24643.
Kral, V. A., 24030, 24147.
Krasowskij, E., 22468.
Krause, L., 23555.
Krauss, T. C., 22647.
Krawiecki, J. A., 22691.
Krebs, A. T., 24572.
Krislov, J., 24286.
Kristjansen, P., 24072.
Kritz, J., 22831.
Kroetz, C., 22333.
Krogman, W. M., 23556.
Krohn, P. L., 22404.
Krook, L., 24523.
Krueger, D. E., 22692, 22700.
Krulee, G. K., 24139.
Kruse, H. D., 22726.
Krusen, E. M., 24031.
Kuga, T., 23030.
Kuhn, R., 24491.
Kuit, C., 23933.
Kullberg, P., 23321.
Kulp, J. L., 22494, 23165.
Kunz, A., 24032.
Kupfer, S. R., 23137.
Kupperman, H. S., 23773.
Kurihara, M., 22997.
Kurihara, S., 24148.
Kurilenko, R. P., 23635.
Kurita, R., 24808.
Kurki-Suonio, E., 23203.
Kurth, G., 24573.
Kutner, B., 24710.
Kutschera, W., 22523.
Kuzmina-Prigradova, A. V., 24501.
Kwaskowski, A., 22546.
Kyrle, P., 22744.
Kyst, J., 23436.
Kytilä, J., 23974.

L

Laadt, J. R., 23085.
Laforgia, P. D., 23791.
Lafratta, C. W., 22882.
Laikhter, B. G., 22535.
Lakin, M., 24736.
Lakonen, M., 24581.
Lamanna, C., 24398.
Lamar, C. P., 24076.
Lambert, R., 22226.
Lamberty, E. R., 22648.
Landis, C., 22547.
Landowne, M., 23727, 23728, 24008.
Lane, L. L., 23744.
Lane, P. W., 24434.
Langmuir, A. D., 23288.
Lanz, H., 22326.
Lanz, U., 23074.
Lapierre, E., 24770.
La Placa, M., 23291.
Laramore, W., 22365.
Larcan, A., 22368, 23721.
Larsen, N. P., 22344.
Larsson, K., 24149, 24737.
Larsson, T., 22801.
LaRue, E., 22760.
Lassen, S., 22294, 23644.
Lasser, R. P., 24470.
La Tona, S. R., 22584.
Latta, M. J., 22605.
Laubach, C. A., Jr., 23745.
Laurent, P., 25806.
LaVeck, G. D., 24696.
Lavell, M., 22780, 24751.
Law, N. R., 24771.
Lawrence, B., 22408.
Lawrence, J. S., 23973.
Lawrence, R. J., 22257.
Lazarus, F., 24454.
Lazerson, J. A., 23425.
Lazlo, D., 24414.
Lea, A. J., 23045, 23204.
Learmonth, A. T. A., 23014.
Leary, G., 22556.
Lebedev, M. I., 23955.
Lecourt, J., 23557.
Ledoux, G., 23847.
Lee, E. S., 23374.
Lee, H., 23504.
Lee, H. Y., 23087.
Lee, K. T., 22424, 23094.
Lee, M. M. C., 24635.
Leeds, M., 22759.
Leerschool, J. J., 24150.
Lefévre, J., 22993.
Lefevre, M. C., 23326.
Leffel, J. M., 23811.
Lehman, H. C., 24151, 24738.
Lehto, L., 22405.
Leichsenring, F., 24534.
Lejeune, J., 22315.
Lemkau, P. V., 22700.
Lengemann, F. W., 24524.
Lennette, E. H., 24699.
Lenz, W., 23666.
Lenzner, A. S., 24711.
Leonard, D., 22548.
Leonard, J., 22359.
Leone, N. C., 22458.
Leonetti, P., 22596.
Leppelmann, H. J., 24491.
Leslie, P. H., 22248.
Leusen, I., 24513.
Lev, R. A., 22535.
Levene, C., 23195.
Levey, H. A., 23776.
Levi, M., 22760.
Levin, M. L., 22640.
Levine, H., 24032, 24042.
Levine, J., 23219.
Levine, L., 24456.
Levine, M., 24163.
Lew, E. A., 22258, 22994.
Lewin, J. C., 23603.
Lewis, F. J., 24527.
Lewis, S. M., 23088.
Lewis, W. H., Jr., 24318.
Lhotka, J. F., 23778.
Liang, I., 22351.
Libov, A. M., 24423.
Lichtenstein, I., 23991.
Lichtor, A., 22568.
Lichtor, J., 22568.
Lichtwitz, A., 22406, 23122.
Lichushina, L. G., 23823.
Likoff, W., 23746.
Lilienfeld, A. M., 24697.
Lill, H., 23313.
Lim, W. N., 22380.
Lindemann, B., 22882.
Linden, M. E., 23327, 23461, 23462.
Linder, A., 22394.
Linder, F. E., 24088.
Lindgren, L., 22512.
Lindholm, R., 23956.
Lindström, B., 22977.
Lingappa, Y., 24339.
Linko, E., 22362.
Lino, E., 24644.
Linsalata, P., 23909.
Lippert, A., 23720.
Lipscomb, H. S., 23770.
Lipsius, E. I., 22549.
Lisan, P., 23747.
Liss, L., 23934.
Litterer, M., 22802.
Little, I. M. O., 23480.
Little, K., 24620.
Liu, W., 24698.
Lloyd, R. G., 22850.
Lodi, R., 23648.
Loeffler, L., 24183.
Löw, H., 24416.
Logan, W. D., 23067.
Logan, W. P. D., 22259.
Lombardi, E., 22443.
London. Empire Rheumatism Council, 22945.
London. The National Corporation for the Care of Old People, 23491, 24241.
London. Round Table, 24220.
Longmire, W. P., Jr., 22221.
Longshore, W. A., Jr., 24699.
Loosen, H., 22469.
López, A., 24184.
Lorenzen, J., 24074.
Lorge, I., 23339, 24752.
Los Angeles County Committee on Aging. Sheltered Care Committee, 22872.
Losty, M., 24032.
Lotte, A., 24394.
Lottenbach, K., 22352.
Lotti, L. M., 22200.
Lovelace, F., 23139.
Lovett Doust, J. W., 22353, 22354, 22693, 22761.
Lovo, G. F., 24718.
Lowe, C., 24430.
Lowe, J. S., 24435, 24519.
Lowe, K. J., 22594.
Lowenthal, M., 23997, 24044, 24077, 24663.
Lublin, F., 23015.
Lubovsky, V. I., 24319.
Lucherini, T., 22582.
Luchterhand, E., 24770.
Lütgerath, F., 23910.
Lukańska, F., 23694.
Lukenbill, A., 22459.
Lumsden, L. I., 24078.
Lund, H. Z., 23984.
Lund, J., 23676.
Lundberg, E., 23375.
Lundgren, C., 23192.
Lundin, G., 23193.
Lunedei, A., 23777.
Lutz, B. R., 24464.
Lutzeyer, W., 23998.
Luxembourg. Office de la Statistique Générale, 22803.
Lyden, M., 24024.
Lynn, W. G., 24502.
Lyons, C., 23160.
Lyons, H. A., 24481.
Lyons, J. B., 23832.
Lyons-Bergman, R., 24207.

M

Ma, R. A., 22804.
McAdam, W., 24152.
Macagnino, G., 23735.
McAllister, F. F., 22569.
McArdle, G. P., 22201.
McArthur, L. G., 23778.
McCall, M. S., 22326.
McCance, R. A., 22456, 23664.
MacCannell, E. H., 24761.
McCarthy, H. L., 22726.
McCay, C. M., 23139, 23657, 23659.
McCrary, J. S., 22899.
MacCuaig, R. D., 22986.
McCulloch, T. L., 23328.
McDonald, D. A., 22347.
McDonald, D. F., 22605.
MacDonald, I., 23254.
MacDonald, R. I., 23202.
McFadden, G. D., 24719.
MacFadyen, D. J., 24447.
McGanity, W. J., 23660.
McGavack, T. H., 22403, 22422.
McGill, H. C., Jr., 24475.
MacGregor, J., 24364.
McGugan, A. C., 24033.
Macháček, E., 24405.
Machida, C., 24505.
Machinko, W. I., 23639.
McIntyre, A. D., 24371.
Mack, M. J., 24221.
Mack, R. E., 23077.
McKain, W. C., Jr., 23376.
Mackavey, W. R., 22769.
McKeown, T., 22232, 23065, 23589, 23739, 23897, 24056, 24057.
McKern, T. W., 23965, 24614.
McKinley, P., 23660.
McLane, C. M., 24593.
MacLeod, J., 24593.
McMahan, C. A., 24772.
MacMahon, B., 22995, 23898.

McMenamin, H. J., 22644.
Macmichael, N., 23234.
MacMillan, D., 24267.
McMorrow, K., 24034, 24079.
McNelis, J. F., 24607.
McNulty, I. B., 23578.
MacQueen, L., 22634.
Macrez, Cl., 23070.
Madding, G. F., 24716.
Magendie, J., 24503.
Magida, M. G., 22370.
Magimel, J., 24503
Magistretti, M., 22527.
Magladery, J. W., 24543.
Magnani, E., 22343, 22649.
Mahadeva, K., 23870.
Maier, B., 24420.
Maier, W., 22805.
Maione, M., 23205.
Maisonnet, M., 22524.
Majima, Y., 22281.
Makarevich, J. A., 24455.
Makarov, N. I., 24574.
Makarova, E. P., 24574.
Makhin'ko, V., 23024.
Malenbaum, W., 22832.
Malinský, J., 23953.
Mallucci, L., 24421.
Maly, V., 22682.
Malzberg, B., 24080.
Manautou, J. M., 23894.
Manfredi, G. C., 23651.
Mangan, G. L., 23329.
Mangel, H., 22694.
Manheimer, R. H., 23255.
Manniche, E., 22762.
Mansfield, E., 23302.
Mantel, N., 24565.
Manthei, C. A., 22489.
Maragi, M., 24664.
Marchese, J., Jr., 22946.
Maréchal, A., 22727.
Maréchal, R., 24665.
Marenghi, I., 22336.
Marg, E., 23206.
Margil, M. Yu., 23591.
Margolius, S., 23505.
Marin, A., 22226.
Marino, D. J., 23709.
Marino, E., 23692.
Marnocha, R. S., 22195.
Marossero, F., 22471.
Marrama, P., 23651.
Mars, G., 22371, 22407, 22563, 23686, 23693, 23985, 24081.
Marshall, A. H. E., 23779.
Martel, M. U., 22900.
Martens, D., 23437.
Marthinsen, A., 23438.
Martin, D. J., 23069.
Martin, W. J., 23610.
Martinetti, R., 23871.
Martinez, J., 23187.
Martini, P., 22695.
Marvel, R. J., 22365.
Marzinkevich, L. D., 23986.
Marzolf, R. C., 24372.
Marzouk, G. A., 22509.
Mason, K. E., 23654.
Massa, B., 23672.
Massachusetts. Department of Labor and Industries. Division on the Employment of the Aging, 22833, 22834.
Massey, F. C., 23744.
Massler, M., 23802.
Masson, A., 24082.
Masson, G., 24518.
Master, A. M., 24470.
Masters, W. H., 23119.
Masters, Y. F., 23100, 23759.
Mastri, A. R., 23683.
Masuda, M., 24504.
Matera, R. F., 22470, 23833, 24615.
Matheson, B. H., 24373.
Mathewson, C., Jr., 22737.
Mathiasen, G., 24822.
Mathiesen, E. Ø., 23815.
Matsuno, N., 24410, 24411.
Matsuno, Y., 23021.
Matsuoka, S., 24406, 24505, 24808.
Mattarella, D., 22650.
Mattison, B. F., 24268.
Matzke, J. R., 23023.
Maujol, L., 24394.
Maurice, H. K., 24841.
May, J. R., 23194.
Maynard, A. de L., 24674.
Mayor, G., 22606.
Mazurczak, J., 23694.
Mazzetti, G., 24111.
Mead, J., 23189.
Meador, R. S., 22528.
Meadow, L., 22835.
Mechalas, B. J., 24358.
Medlianik, I. A., 23140.
Medvedev, Zh. A., 23579, 23604.
Mehta, F. S., 23143.
Meissner, F., 22745.
Meissner, W. W., 24739.
Melik-Pashaev, N. Sh., 24112.
Melkild, A., 23120.
Mellerowicz, H., 23857.
Melly, M. A., 24380.
Meltzer, H., 23330.
Melvin, D. M., 24554.
Meneses Hoyos, J., 23089.
Menger, P., 24740.
Mennell, J. M., 22583.
Meredith, D., 24527.
Merkov, A. M., 22806.
Mermod, C., 24035.
Merrill, G. G., 22763.
Mervine, C. K., III, 24624.
Meshchetiakov, A. I., 24319.
Měštan, J., 23697.
Mestler, G. E., 24459, 24632.
Metcalf, D., 24395.
Metrop. Life Insur. Co., 22233, 22234, 22260, 22282, 22981, 22996, 23331, 23342, 23611, 23612, 23748, 24083, 24167, 24185, 24351, 24396, 24397, 24407, 24773.
Metz, D., 23997, 24041.
Mewissen, D. J., 23872.
Meyer, H., 24208.
Meyer, K. A., 24720.
Meyer, W. W., 24471.
Mezzadra, J., 22511, 22513.
Mezzasalma, G., 23693, 23749, 23751, 24482.
Miall, W. E., 23729.
Miatello, V. R., 22355.
Michael, C. M., 22752.
Michaels, L., 23195.
Michel, D., 22372, 23750.
Michigan State Medical Society. Geriatrics Committee, 22728.
Michlin, D., 22651.
Mickelsen, O., 23873.
Middleton, A. G., 24468.
Migeon, C. J., 22408.
Migliore, A., 22471.
Mikat, B., 22652.
Mikhailova, V. N., 24636.
Mikič, F., 22329.
Miller, A. R., 23374.
Miller, C. D., 23640.
Miller, D. J., 24364.
Miller, J. H., 23449.
Miller, L. A., 24422.
Miller, R. B., 24374.
Miller, R. E., 23958, 24038.
Miller, W. J., Jr., 23506.
Millikan, C. H., 24550.
Mills, L. C., 23780.
Milne, G. G., 24741.
Milner, K. C., 23885.
Minerva, V., 23064.
Mini, M., 24123.
Minkoff, A. B., 22653.
Minoru, T., 24760.
Mise, J., 24597.
Mississippi. Economic Council. Committee on State and Local Government, 23481.
Mississippi. State Department of Education. Division of Vocational Rehabilitation, 23558.
Misurale, F., 24506.
Mitchell, H. H., 22305, 23655.
Mitchell, J., 24742.
Mitchell, J. H., 23874.
Mitchell, J. M., Jr., 23332.
Mitroganova, V. M., 23635.
Moberg, S., 23413.
Moine, M., 24394.
Molchanova, V. V., 23760, 23761.
Mole, R. H., 23173.
Molinari, S., 22377.
Moller, G. A., 22441.
Mondet, G., 23146.
Monges, A., 22446.
Monges, H., 22446.
Mongin, M., 22202.
Monroe, R. T., 22615, 24666.
Monsaingeon, A., 22444.
Montagnari, F., 22461.
Montgomery, H., 22714.
Montgomery, J. D., 22935.
Montgomery, W. W., 23801.
Montoreano, F., 24575.
Montoye, H. J., 23174.
Moore, M. C., 23658.
Moorehead, H. H., 24153.
Moraes, N. L. De A., 24408, 24409.
Morassutti, M. P., 22327.
Morehouse, W. G., 24089.
Moretti, G., 24634.
Moriyama, I. M., 23613.
Morpurgo, C. V., 24576.
Morpurgo, M., 22371, 22407, 23175, 23693, 23749, 23751, 24081, 24482.
Morrison, B. O., 24084.
Morrison, F. S., 23614.
Morrison, L. M., 23038.
Morrison, S. L., 22836.
Morrissey, A. B., 22654.
Morsica, R., 24555.
Mortara, G., 23016, 23377, 23402, 23899.
Morton, R. A., 24435, 24519.
Morton, W., 23256.
Mosca, L., 23781, 24507.
Mosci, L., 23935.
Moskowitz, E., 24037.
Moss, L. D., 23716.
Mosso, H. E., 22373.
Mouquin, M., 23070.
Moyer, J. H., 23148, 24009, 24085, 24467.
Mrost, I., 24454.
Mühlbock, O., 22409, 23567, 23580.
Mueller, A., 23890, 24587.
Mukerji, B., 23104.
Mulcare, D., 23662.
Mulholland, H. B., 22696, 23450.
Muller, K., 22472.
Munford, R. E., 24508.
Munnich, K. O., 22203.
Munter, E. J., 23292.
Murphey, H. K., 22851.
Murphy, C. M., 22594.
Murphy, J. T., 24783.
Murray, P. R., 22550.
Murrell, K. F. H., 22837, 24774.
Musaev, M., 23592.
Musci, J., 23050.
Mushkin, S., 22883, 23451.
Mussa, L., 22562.
Muto, T., 22249.
Myers, A. F., 24222.
Myers, R. J., 22852, 22915, 24823.
Myerscough, P. R., 23103.
Mysak, E. D., 24743.
Mysyutkina, M. V., 22495.

N

Naber, A. N., 23426.
Nadel, E. M., 24452.
Nadel, M. B. J., 24667, 24668.
Naef, A. P., 22445.
Nagai, S., 24476.
Nagamine, S., 23030.
Nagel, H., 23785.
Nagorski, F., 23694.
Naish, J. M., 23911.
Nakamura, H., 24476.
Nalbandov, A. V., 23763, 23774, 24500.
Naldrett, S. N., 24320.
Naora, H., 24525.
Napp-Zinn, K., 22217.
Naqvi, S. H. Z., 24340.
Nash, F. A., 24577.
Nash, J. B., 22325.
Natenshon, A. L., 24669.
Nath, H. P., 23057.
Nathanson, N., 23288.
National Education Association. Department of Classroom Teachers and Research Division, 24784.
National Education Association. National Council on Teacher Retirement, 24785.
National Education Association. Research Division, 24786, 24832.
(The) National Old People's Welfare Council, 22901.
National Social Welfare Assembly, Inc. National Committee on the Aging, 24787.
Naudin, E. P., 22570.
Nava, C., 23290.
Nazzi, V., 22327.
Neess, J., 23890.
Negre, L., 24601.
Neiman, V. N., 22535.
Nelke, A., 22589.
Nelson, C. T., 24637.
Nelson, N. H., 23991, 24638.
Nelson, R., 22308, 23176.
Nepveux, P., 23146.
Netherlands. Central Bureau of Statistics, 22283, 23017, 23378, 24186.
Neumann, G., 24223.
New Jersey. Department of Conservation and Economic Development. Bureau of Recreation, 22936.
New Jersey. State. Old Age Study Commission, 24824.
Newman, D. W., 23578.
Newsham, L. G., 23788.
Newsom, C. V., 24234.
New York. Committee for the Special Research Project in the Health Insurance Plan of Greater New York, 23452.
New York. Community Council. Committee on Employment and Retirement Practices for Older Workers, 24300.
New York. Community Research Associates, Inc., 24825.
New York. Council of Jewish Federations and Welfare Funds, 23439, 24301.
New York. Health Information Foundation, 22966, 23507, 23615, 23616, 24670.
New York. National Health Council, 22697.

New York. National Lutheran Council. Division of Welfare, 24242.
New York. National Social Welfare Assembly. National Committee on the Aging, 22838.
New York. Office Executives Association, 23414.
New York. Pension Planning Company, 22853.
New York. State Conference on Financing Health Costs for the Aged, 22884.
New York. State Department of Commerce, 23379.
New York. State. Department of Labor. Division of Research and Statistics, 24224.
New York. State Education Department, 23492.
New York. University. Conference on Labor, 24225.
New Zealand. Department of Statistics, 22839, 23380.
New Zealand. Social Security Department, 22916.
Nicholas, L., 23987.
Nicholls, W. H., 23381.
Nichols, C. R., 24725.
Nicholson, A., 23508.
Nicholson, E. E., 23440.
Niehans, P., 24671.
Niehaus, F. W., 24086.
Nielsen, A., 24062.
Niemi, T., 22337.
Nikitin, W. N., 23675, 23803, 23823, 24352.
Nikitina, G. G., 23731.
Nikkilä, E. A., 22337.
Nisbet, J. D., 23333.
Nishihara, A., 24411.
Nishikawa, S., 24406, 24476, 24505, 24808.
Noble, N. L., 23097, 24489.
Noller, H. E., 23875.
Norcross, B. M., 22584.
Nordenbrand, K., 24416.
Nordlander, N. B., 22309.
Norman, T. D., 23834.
Norris, A. H., 24543.
Norris, D. A., 22310.
North Carolina. State Board of Public Welfare, 24226.
North Dakota. Public Welfare Board. Division of Research and Statistics, 23403.
Northfield, D. W. C., 24544.
Northup, D. W., 23090.
Norton, H. W., 23763, 23774, 24500.
Norton, P. M., 23020.
Norway. Statistisk Sentralbyrå, 24227.
Norwegian Joint Committee on International Social Policy, 23441.
Nosko, L., 23228.
Notestein, F. W., 23382.
Notley, B., 24243.
Novack, P., 23835.
Novak, J. B., 22519.
Novikova, N. M., 23804.
Novitski, E., 23043.
Novotný, M., 22698.
Nubarian, —., 22218.
Nyboe, J., 23912.
Nykliček, O., 23121.
Nyrek, St., 23694.

O

Oberhoffer, G., 22496.
Occhipinti, S., 23641.
Odinzova, M. S., 2'581.
Odland, L. M., 23966.
O'Doherty, B., 22614.
Odoroff, M. E., 23257.
Öberg, L., 22284.
Oehme, J., 24472.
Østergaard, E., 24509.
Oettlé, A. G., 23805.
Offutt, A. C., 24554.
Ofner, F., 23695.
Ogawa, K., 24406.
Ogawa, T., 24808.
Ohela, K., 22410.
Oka, M., 23974.
Okada, M., 24425.
Okinaka, S., 24483, 24484.
Olaizola Segurola, I., 22481.
Olbrich, O., 22457.
Oldham, P. D., 23729.
Olin, T. D., 24154.
Olinger, L., 24054, 24684.
Oliva, O., 24375.
Olmsted, K. E. P., 23207.
Olsen, H., 22690, 22699.
Olsen, I. N., 24744.
Olson, H. W., 23174.
Olsson, B., 24209.
Ômura, Y., 24406, 24808.
Ontario (Canada). First Conference on Aging, 22967.
Oomen, H. A., 23936.
O'Reilly, C. T., 24269.
Orfei, E., 23050.
Orma, E. J., 23218.
Orme, J. E., 22764.
Orto, L. A., 23033, 23683.
Osborn, F., 22807.
Oshima, S., 23030.
Osipova, S. V., 23876.
Ossman, S., 23404.
Oswald, N. C., 23194.
Otis, H. W., 22854.
Otten, C. M., 24627.
Otturi, J. E., 22511.
Owchar, M., 22262.
Owen, M., 24578.
Owens, R. E., 23957.

P

Pacilio, V., 23133.
Paerregaard, G., 24072.
Pagani, A., 22656, 22808, 22879, 24279, 24809.
Page, I. H., 23073.
Pagès, A., 22414, 22415, 22416, 22475, 22592.
Pagni, C. A., 22471.
Pál, F., 23617.
Palazzetti, P., 23046.
Palladin, A. V., 22473.
Pan American Union. Departamento de Asuntos Culturales. Oficina de Ciencias Sociales, 23383.
Panchenko, L. F., 24545, 24546.
Pang, S. C., 23289.
Panichi, S., 22411.
Paniev, N., 23592.
Panse, F., 24700.
Paoli, J., 23891.
Paolillo, G., 24842.
Pappalardo, G., 23025.
Pappas, W., 24270.
Paraf, A., 23128.
Paramonova, N. P., 23836.
Parchwitz, E., 24335.
Pareja, B., 23685.
Parhon, C. J., 24672.
Parhon, K. I., 23044.
Parina, E. V., 22973, 23635, 23642.
Park, H. W., 23958, 24038.
Parker, A. H., 22250.
Parker, H. G., 23877.
Parker, L. B., 22585.
Parlier, R., 22406, 23122.
Parsons, E. H., 24051.
Parsons, L., 22615.
Pasamanick, B., 22700.
Pashkar, S. I., 22219.
Passarelli, E. W., 22587.
Passmore, R., 23870.
Patnaik, N., 24187.
Patroni, N., 22529.
Patrono, V., 22412.
Patton, A., 23997.
Paul, O., 22714.
Pauling, L., 24353.
Paulino-Gonzalez, C. M., 24558.
Payan, H., 22446.
Payne, I. R., 24460.
Payne, R. W., 23977.
Peale, N. V., 24846.
Peale, R. C., 24846.
Pearson, J. S., 24087.
Peden, J. C., Jr., 23026.
Pedersen, E., 22261.
Pedersen, J., 23676.
Pegel, L. A., Jr., 24436.
Pehrson, R. N., 24280.
Pekkarinen, A., 23123.
Pelech, J. T., 23091.
Peleska, M., 23928, 23929.
Pelner, L., 23177, 23878.
Pelosio, C. E., 23124.
Pembroke, M. M., 24269.
Pende, N., 22204.
Pendse, G. S., 23208.
Pennsylvania. Bureau of Aging. Health and Welfare Federation of Allegheny County, 22937.
Penrose, L. S., 23667.
Peoria (Ill.). Community Chest and Council, 24271.
Péquignot, H., 24010, 24244.
Perin, A., 23075.
Perkowska, E., 24453.
Perrott, G. St. J., 24088.
Perrow, C., 22855.
Perry, E. T., 23937.
Perry, W. F., 23027.
Peschel, E., 23679.
Pestalozza, G., 23938.
Peszczynski, M., 23220, 23837.
Peters, H., 22357.
Petersen, J. C., 23159.
Petit, J. L., 22580.
Petrásek, R., 24571.
Petrunkina, A. M., 24423.
Petty, P. V., 24780.
Pevey, K., 24085.
Peycelon, R., 23806.
Pflugfelder, O., 24376.
Phair, J. J., 23196.
Philadelphia Health and Welfare Council. Division on the Aging, 24810.
Philadelphia Housing Association. Committee on Housing for Older People, 24811.
Phillips, A. J., 22262, 22701, 23618.
Phillips, B. S., 22902.
Phillips, E. C., 22657.
Piantoni, G. G. H., 24321.
Piazzesi, W., 23277, 23293.
Pichler, E., 22840.
Pichot, P., 23334.
Pick, E., 23258.
Pickett, K. G., 23850.
Piechottka, E., 23125.
Piédrola Gil, G., 23384, 23442.
Pierce, D. L., 24464.
Pierce, J. A., 24602.
Pierre-Bourgeois, —., 24526.
Pierson, W. R., 23174.
Piggot, A. P., 24071.
Pilgeram, L. O., 23071.
Pilgrim, H. I., 22413.
Pillet, J., 24621.
Pilote, J., 24770.
Pimm, L. H., 24620.
Pin, R., 33816.
Pincock, J. G., 22474.
Pincus, G., 22419.
Pindborg, J. J., 23967.
Pineo, P. C., 24136.
Pingoud, A., 23956.
Pinner, J. I., 24210.
Pirie, N. W., 22191.
Pirone, F. J., 22658.
Pisani, S., 23259.
Pitteloud, J. J., 23879.
Plamondon, C., 24535.
Planel, H., 23108.
Plattner, H. C., 22702.
Plauchu, M., 24518.
Plisskin, B., 24039.
Ploegmakers, N., 24011.
Podesta, A., 23641.
Podolsky, E., 24155.
Poinso, R., 22446.
Poland. Główny Urzad Statystyczny, 22809, 24188.
Pollack, H., 22403, 23039.
Pollack, M., 24156.
Pollak, O., 23427.
Pollak, O. J., 23696.
Polman, A., 22983, 23595.
Polner, W., 24814.
Pomeranze, J., 23260.
Pomrinse, S. D., 23261, 24673.
Popa, A. V., 24547.
Popova, Z. A., 23161.
Portella, A., 22331.
Porter, R. H., 24341.
Posch, J. L., 23229.
Posniak, A. O., 24663.
Post, F., 22687, 24687.
Post, J., 23141.
Posternak, D., 22525.
Posth, H. E., 22742, 24127.
Pototschnig, B., 22526.
Poupa, O., 24418.
Powell, M., 22290.
Pradhan, L. B., 24377.
Prados, M., 24157.
Pratt, E. L., 23020.
Pratt, G. N., 22714.
Pratt, L. O., 23509.
Pressey, S. L., 22765.
Pretel-Martines, A., 22252.
Price, A. B., 24287.
Priest, R. E., 22485.
Prigot, A., 24674.
Prigozhina, E. L., 24378.
Proctor, R. C., 24089.
Prokop, O., 22496.
Prosser, R. R., 22205.
Proud, D. M., 22659.
Prusík, B., 23697.
Puech, A., 22414, 22415, 22416, 22475, 22592.
Putnam, A., 24158.
Pye, A., 22417.
Pygott, F., 24622.
Pyke, D. A., 23782.

Q

Quay, W. B., 24510.
Quensel, C.-E., 23385.
Quenzlein, J., 24522.
Querido, A., 24701.
Quimby, D. C., 24379.

R

Rabenko, J., 22746, 24575.
Rabin, H. M., 24159.
Radich, B., 24090.
Radó, J., 23752.
Radus-Zen'Kovich, V. A., 24833.
Ragab, M. T., 24594.
Raible, K., 23028.
Ralph, K. M., 24745.
Rambaldi, P., 22346.
Rancati, A., 22808, 24812.
Ranck, M., 22660.
Randall, C. L., 23126.

Randall, H., 24228.
Rankin, J., 22476.
Ranson, R. M., 22248.
Rapaport, A., 24604.
Rapoport, S., 23637.
Rappaport, M. B., 23753.
Rassi, E., 24600.
Ratcliffe, H. L., 24473.
Ravera, M., 22418.
Ray, C. T., 22292.
Raynes, H. E., 24288.
Reber. H., 23074.
Record, R. G., 23897.
Reed, G., 24289.
Reed, R., 22591.
Reeves, J. L., 23206.
Reeves, M. M., 24527.
Reibel, S., 24587.
Reich, T., 22263, 22264.
Reid, M., 22661.
Reif, A., 22766.
Reimann, S. P., 23559, 23659.
Reimers, F. E., 24342.
Rein, C. R., 24637.
Reinhardt, F., 23677.
Reiser, M. P., 24116.
Reissig, G., 23863, 23864.
Reissman, L., 22767.
Rentchnick, P., 23262.
Répaci, M., 22703, 24675.
Replumaz, P., 23806.
Reyes, A. C., 24398.
Reynolds, F. W., 22640.
Reynolds, M. S., 23643.
Rezek, P. R., 24076.
Ricci, M., 23235.
Richardson, F., 24272.
Richardson, S. D., 24343.
Richburg, P. L., 22528.
Richlin, M., 24728.
Richter, W. C., 22338.
Rico, L. R., 22389.
Rider, J. A., 23698.
Riegel, K. F., 24746, 24747.
Riesman, D., 23317.
Rietsch, R., 23230.
Rigas, D. A., 24445.
Riklan, M., 23827.
Riley, J. S., 23026.
Ringer, R. K., 22374.
Rinsky, A., 23560.
Riondel, A., 22394.
Rizzente, S., 22343.
Robbin, J. S., 24724.
Roberts, D. W., 22700.
Roberts, G. W., 22593.
Roberts, J., 23463.
Roberts, N. J., 24113, 24229.
Roberts, S., 23776.
Robertson, D. H., 22237.
Robertson, J. D., 24424.
Robins, M., 23251.
Robinson, D. B., 23294.
Robinson, H. M., Jr., 24637.
Robinson, R. A., 24152, 24623.
Rochwarg, H., 22768.
Rock, J., 24437.
Rocklyn, E. H., 23335.
Rockstein, M., 22251.
Rodahl, K., 23880.
Rodman, M. J., 24040.
Rodofsky, M., 24091.
Rodriguez-Busuego, M., 24558.
Rodstein, M., 23072.
Rösch, G., 24189, 24244.
Rössler, G., 23959.
Rogé, J., 24526.
Rogel, R., 22856.
Rogers, D. E., 24380.
Rogers, E. J., 22477.
Rogers, J. B., 23938.
Rogoff, J., 24041.
Rolandi Ricci, V., 22418.
Rollerson, E., 24490.
Romagnoli, G., 24463.
Romanoff, L. P., 22419.
Romatowksi, H., 22220.
Ronco, P. G., 24139.
Roof, M. K., 22810.
Root, H., 22403.
Ropes, M. W., 22615.
Ros, C., 22391.
Rosen, S., 24532.
Rosenbaum, G., 22769.
Rosenberg, G., 23783, 24609.
Rosenblum, M. H., 22375.
Rosenfeld, S., 23142.
Rosenman, R. H., 22301.
Rosenthal, T., 23295.
Rosner, H., 24165.
Rosolini, D., 23913.
Ross, C. H., 22662, 24702.
Ross, E., 22293.
Ross, M., 22729.
Rossier, P. H., 22522.
Rossman, I., 22770.
Rossmann, B., 23807.
Roth, F., 22420.
Roth, F. B., 23296.
Roth, H. P., 24528.
Rothe, A., 22423.
Rothman, K., 24042.
Rottier, P. B., 23983.
Rouillon, A., 24394.
Rouse, M. O., 24272.
Roussin, J. J., 24740.
Roversi, A. S., 22563.
Rowntree, J. A., 24190.
Roy, A. B., 23881.
Rozova, K. A., 24012.
Rubbens-Franken, E., 22206.
Rubens-Duval, A., 22586.
Rubin, B., 24281.
Rubin, M., 24322.
Rubin, M. J., 23960.
Rucker, A. W., 23405.
Rucker, C. W., 22551.
Rudajeva, A. W., 24344, 24511.
Rudali, G., 23605.
Rudd, T. N., 22497.
Rugarli, C., 22356.
Ruiz Villanueva, E., 24645.
Rush, L. V., 23968.
Rusk, H. A., 22704, 23263, 24230.
Russell, C. S., 23185.
Russell, J. K., 22510.
Rutherford, A., 22712.
Rutland, J. P., 23049.
Ruttloff, H., 23582.
Ruygikh, G. N., 24492.
Ruys, A. C., 23619.
Ryden, G., 22512.
Ryder, C. F., 22615.
Ryzhikh, G. N., 23762.

S

Saari, K., 23321.
Sabbadini, G., 23152.
Sagal, Z., 24579.
Sage, L. A., 23969.
Sage, V., 24766.
Sahaski, Y., 22249.
St. Helena. Education Office, 23386.
Sajner, J., 23882.
Sakhatchiev, A., 23178.
Salamone, L., 23297.
Salfeld, K., 22590.
Salganik, R. I., 23699.
Salk, L., 24233.
Salomon, Y., 24244.
Salon, N. L., 22885.
Saltzman, M., 22552.
Salvini, L., 22341, 23277.
Sammartino, R., 22511.
Samson, F. E., Jr., 24580.
Samtsova, A. V., 24160.
Samuel, P., 23741.
Samuels, L. T., 23700.
Sandberg, F., 22512.
Sanderson, W. A., 24298.
Sandler, L., 23043.
Sandstead, H. R., 23660.
Sanjana, M. K., 23143.
Sansone, G., 22531.
Santiago de Chile. Centro Interamericano de Bioestadística, 23186.
Santillan, J. S., 22917.
Sappenfield, R., 24554.
Sarkisov-Serazini, I. M., 23593.
Sartorelli, E., 22498, 22527.
Sartori, S., 23060.
Sataloff, J., 23209.
Saubier, E. C., 24529.
Sauthoff, R., 23883, 23884.
Sauvy, A., 23387.
Savage, B., 22873.
Savastano, A. A., 23969.
Savelova, K. A., 22495.
Saville, J., 23388.
Sayre, G. P., 24550.
Sbertoli, C., 22527.
Scaglione, S., 23900.
Scalfati, P., 23298.
Scarborough, W. R., 23092.
Scardigli, G., 24250, 24659, 24676.
Schaeffer, J. N., 22644.
Schaie, K. W., 22778.
Schall, E., 22705.
Schaller, W. F., 23163.
Scharf, R., 22352.
Schechter, D. C., 23314, 24624.
Scheibe, H., 24700.
Scheinfeld, A., 22982.
Schenck, E. G., 22311.
Scheuer, F., 22571.
Scheyer, W. J., 22483.
Schiavetti, L., 23970.
Schiele, B. C., 24051.
Schievelbein, H., 23808.
Schiffer, D., 22478, 23838.
Schiffman, J., 24211.
Schiller, R., 23510.
Schindler, O., 23074.
Schindowski, E., 23905.
Schinz, H. R., 22263, 22264.
Schlesinger, E. R., 22640.
Schlomka, G., 23678, 23679.
Schlossman, A., 23939.
Schmeiser, A., 23959.
Schmid, C. F., 24761.
Schmidt, H. W., 23988.
Schmidt-Voigt. J., 23754.
Schmitz, H. E., 22710.
Schneckloth, R. E., 23073.
Schneider, J., 22545, 22553.
Schneider, R., 24454.
Schoen, L., 24537.
Schönfellinger, H., 24349.
Schoffman, R. J., 24381, 24382.
Schofield, R. D., 24383.
Schollmeyer, P., 24471.
Schrader, C. P., 23982.
Schraer, H., 22421.
Schraer, R., 22421.
Schreuder, J. Th. R., 23264, 23265.
Schubert, R., 22357.
Schuberth, G., 22496.
Schütz, K., 24278.
Schulert, A. R., 22494, 23165.
Schulte, K., 22572.
Schulte, W., 22771.
Schulz, Fr.-H., 23052, 23561.
Schulze, W., 22312.
Schuppius, A., 23127.
Schwartz, A., 23842.
Schwartz, C. J., 24461.
Schwartz, P., 22265.
Schwarz, E., 23074.
Schweizer, W., 23074.
Schwemmle, J., 24345.
Scolari, E. G., 23989.
Scott, F. G., 24762.
Scrimshaw, N. S., 24426.
Seegers, W., 22422.
Seegmiller, J. E., 23224.
Segal, E., 23854.
Segar, W. E., 22459.
Segi, M., 22997.
Seibert, R. A., 23148.
Seidel, H., 23971.
Seidel, K., 23839, 23840.
Seidenwurm, J., 23471, 23472.
Sein, M., 23482.
Seitz, R., 23940.
Seliger, V., 23171, 23172.
Seljeskog, E. L., 23817.
Sellers, C. W., 24231.
Semenov, S. P., 23841.
Semeraro, E., 22554.
Seneca, H., 23040.
Serényi, P., 23914.
Serrano, S., 22747.
Settel, E., 22706, 22707, 23266, 23299, 23300, 24093.
Seven, M. J., 23978.
Severgnini, B., 24081.
Severi, A., 24129.
Severi, C., 23075.
Sezoko, S., 24476.
Shaffer, M. F., 23885.
Shafiro, I. B., 23632.
Shankman, S., 22294.
Shannon, I. L., 22447.
Shapiro, M. B., 22687.
Sharkevich, I. N., 23635.
Sharma, R., 23104.
Sharp, G. S., 22294, 23644.
Shaulina, O. E., 23961.
Shaw, P. H., 24273.
Sheard, M. H., 24677.
Sheddon, I. B., 23233.
Shekhter, M., 23784.
Sheldon, H. D., 23389, 24763.
Sheldon, J. H., 23267, 23562.
Shelley, W. B., 23937.
Shepard, T. H., II, 22408.
Shephard, R. J., 23196.
Shepherd, M., 22708.
Sheps, C. G., 23453.
Sheps, J., 22772.
Shetlar, M. R., 23100, 23759, 24458.
Shields, D. O., 22528.
Shimada, K., 24505.
Shimizu, K., 24406.
Shimizu, N., 24425.
Shindell, S., 23301.
Shiner, M., 24530.
Shock, N. W., 22207, 22208, 23019.
Shore, H. H., 23661, 24302, 24303.
Short, P. A., 22479.
Shrut, S. D., 22773.
Shulman, G. E., 23024, 23639.
Shulsky, S., 22857.
Shurian, I. M., 23680.
Sica, S., 22858.
Siegel, B. M., 23268.
Siegel, P., 22423.
Sigler, L. H., 24399.
Siirala, U., 22555.
Silin, O. P., 23645, 23803, 23823.
Silver, A. A., 23785.
Silver, R. J., 24270.
Silverman, S., 24016.
Silvestri, U., 23058, 23231, 23990.
Simon, A. J., 24656.
Simon, K., 22328.
Simonelli, M., 23941.
Simonenko, A. S., 24678.
Simpson, H. E., 22448.
Sinclair, H. M., 22313, 23041.
Sinclaire, H A., 22435.
**Singer, I., 24581.**
Singleton, A. O., Jr., 22358.
Siniscalchi, R., 22709.

Sinkovics, J., 24384.
Sisakian, N. M., 23581.
Sissons, H. A., 24578.
Sjoestroem, B., 24480.
Sjövall, T., 24595.
Skanse, B., 23059.
Skerlj, B., 22499, 22500, 22501.
Sladden, R. A., 23681.
Slaughter, D. P., 22710.
Slobe, F. W., 22918.
Slocum, W. L., 23464.
Sluzynski, L., 22711.
Smigel, J. O., 22594, 24679.
Smirk, F. H., 23076.
Smirnoff, V. N., 22774.
Smit, Z. M., 22266.
Smith, A. G., 24640.
Smith, B. C., 22403.
Smith, D. H., 22573.
Smith, H. H., 23660.
Smith, J. A., 22712, 23302.
Smith, J. E., 24582.
Smith, J. M., 22235, 23886.
Smith, M. E., 22775, 23336.
Smith, R. F. W., 24232.
Smith, R. L., 22267.
Smith, T. L., 24191.
Snyder, M. A., 23270.
Sobel, H., 23991, 24638.
Sobel, I. J., 23646.
Sobey, W. R., 23887.
Sokoloff, L., 22564.
Sokolova-Natanson, E. P., 23620.
Solomon, S. A., 22542.
Sommelet, J., 24619.
Sommers, S. C., 23236.
Sommerville, R. L., 23984.
Somogyi, S., 22811.
Sopchak, A. L., 24748.
Sopozinska, E. B., 23642.
Sorrentino, F., 22597.
Sotgiu, G., 22449, 24323.
Soule, G., 24324.
Soule, S. D., 24588.
Soutter, F. E., 22573.
Sowden, E. M., 24625.
Spain, D. M., 22376.
Spann, W., 22224.
Sparacia, A., 24130.
Speakman, D., 23415.
Spector, S., 24826.
Spellen, B., 22422.
Spencer, H., 24414.
Sperling, G., 23139.
Speyer, N., 22713.
Spiegelman, M., 22268, 22994.
Spielmann, L., 23910.
Spirin, A. S., 22252.
Spitzer, R. S., 22424.
Spjut, H. J., 24583.
Spoto, P., 22748.
Sprague, H. B., 23095
Spriggs, A. I., 23681.
Sproule, B. J., 23874.
Squibb, R. L., 24426.
Srnec, J., 22682.
Stadler, J., 23862.
Stafford, C. E., 23809.
Stafseth, H. J., 24532.
Stamler, J., 23095, 23613, 24474.
Standen, O. D., 24584.
Star, S. A., 23317.
Starr, P., 23113.
Stastny, R., 23144.
Stavitskaia, L. I., 23029.
Stavizkaja, L. I., 23803.
Steckel, H. A., 24161.
Steel, D. L., 23643.
Stefansson, V., 23018.
Stein, E., 24466.
Stein, L. L., 23269.
Stein, M., 23674.
Steiner, P. O., 23406.
Stel'makh, L. N., 23942, 23943.
Stern, J., 23416.
Stern, J. A., 24749.
Stern, K. G., 22334.
Stevens, I. M., 24699.
Stevens, L. C., 24512.
Stevenson, A. W., 23962.
Stewart, L. H., 24788.
Stewart, T. D., 22574, 23965.
Stickney, J. C., 23090.
Stidworthy, G., 23100.
Stieglitz, E. J., 24847.
Still, H. N., 24827.
Still, J. W., 22903, 24848.
Stinnett, T. M., 24782
Stitch, S. R., 24625, 24626.
Stocks, P., 22269.
Stolfi, R., 22529.
Stoll, W. A., 22776.
Stolnitz, G. J., 23390.
Stone, C. L., 23464.
Stone, C. T., Sr., 22714.
Stone, J., 22556.
Storey, E., 23810.
Stosiek, M., 24537.
Strassmann, G., 23162.
Strauss, B., 22715.
Strauss, E. B., 22777.
Strecker, E. A., 24113, 24162.
Streib, G. F., 23465.
Streitfeld, F. H., 22370.
Streitmann, B., 23232.
Strøm, A., 22841.
Strong, J. P., 24475.
Strong, L. C., 24440.
Strother, C. R., 22778.
Struk, V. M., 22339.
Strukov, V. A., 24646.
Stuckey, D., 24485.
Sturkie, P. D., 22374.
Sturman, M F., 24528.
Sudan. Ministry of Social Affairs. Population Census Office, 23391.
Sullivan, J. F., 23077.
Sullivan, J. H., 23915.
Sulzberger, M. D., 24637.
Sundell, C. G., 22716.
Surikow, M. P., 23786.
Suter, L., 23074.
Sutherland, D. A., 22326.
Suvorova, G. A., 23675.
Suzuki, S., 23030.
Swader, J., 23698.
Swaim, W. T., Jr., 24245.
Swaroop, S., 23621.
Swartz, F. C., 23466.
Swendseid, M. E., 23662.
Swenson, W. M., 22663.
Swepston, E. R., 22195.
Swernov, J., 24414.
Swyer, G. I. M., 22425.
Sylvest, O., 22690.
Sysoev, A. F., 23888.
Szabady, E., 22783.
Szabó, D., 23107.
Szalay, E., 23107.
Szathmáry, J., 22502.
Szczepanik, E. F., 22804.
Szilagyi, N., 24486.
Szoke, K., 22575.

**T**

Tachabana, K., 24750.
Tadokoro, K., 23021.
Taeuber, C., 23392, 24192, 24193.
Taeuber, I. B., 24193, 24194.
Täufel, K., 23582.
Tagliacozzo, R., 23152.
Takabatake, E., 23031.
Tamura, E., 24410, 24411.
Tanner, J. M., 23889.
Tappeiner, J., 23228.
Taran, L. M., 24486.
Tardy, A., 22562.
Tarjan, R., 22575.
Tarquini, A., 24477.
Tarugi, P., 24843.
Tarver, J. D., 22812.
Taschini, P., 24463.
Tassinari, G., 23816.
Tattan, J. V., 22779.
Tattoni, G., 23078.
Tauber, J., 23093.
Taubert, M., 23702.
Tayback, M., 22717, 24195.
Taylor, E. J., 24230.
Taylor, E. K., 23322.
Taylor, J. G., 24255.
Taylor, S., 24703.
Taylor, S. G., III, 22710.
Taymor, J., 23916.
Teasdall, R. D., 24543.
Tejada, C., 24475.
Tempelis, C., 23890, 24587.
Tempestini, O., 22998.
Tenchov, G., 23178.
Tenette, C., 22368.
Tenette, M., 22368, 23721.
Tennent, J. J., 22718.
Tenney, R. I., 24358.
Teodori, U., 23594.
Terada, H., 24632.
Terasaki, P. I., 22221.
Terio, B., 23791.
Terroine, T., 24438.
Terry, F. J., 22664.
Terry, R. J., 23792.
Terry, W. D., 22995.
Terzano, G., 22513.
Tester, A. L., 24385.
Thamsen, A., 23800.
Thiébaud, A., 24813.
Thieme, F. P., 24627.
Thomas, C. B., 23755.
Thomas, M. H., 24542
Thomas, W. A., 22424, 23094.
Thompson, C. M., 24531.
Thompson, D. J., 22965, 23093.
Thompson, R., 23337.
Thompson, W. E., 22859, 23465.
Thompson, W. H., 23811.
Thomson, J. G., 23489.
Thoré, L., 23393.
Thornbury, R. T., 24136.
Threefoot, S. A., 22292.
Thung, P. J., 22222, 22426, 22978, 23567, 23787.
Tibbitts, C., 22947, 22948, 22949, 22958, 24680, 24763.
Tiberin, P., 23842.
Tietz, N., 22742, 23738, 24127.
Timeche, L., 23660.
Titchener, J., 24163.
Tixier-Vidal, A., 23583.
Tizzano, A., 23633.
Tobis, J. S., 24043, 24044.
Tochinskii, Yu. M., 23822.
Tolksdorf, M., 22220.
Tolstoi, E., 22403.
Tomlin, E. M., 22608, 24000.
Tommaselli, A., 22377.
Tomson, F. I., 24704.
Tonna, E. A., 23221, 24427, 24628.
Toor, M., 23703.
Torpin, R., 24596.
Torr, J. B. D., 22975.
Torre, M., 24441.
Torsello, R., 23046.
Tourlentes, T. T., 23303.
Townsend, P., 23473, 24282.
Traub, E. F., 24637.
Traut, E. F., 22587.
Trefný, Z., 23171, 23172.
Triller, J., 23471, 23472, 23474.
Trnka, V., 22514.
Troccoli, B., 22649.
Troedsson, B. S., 24045.
Trojan, J., 24325.
Trolle-Lassen, C., 23815.
Trompeo, G., 24393.
Troshichin, W. A., 24164.
Trueta, J., 24620.
Tsoükas, A. G., 23243.
Tsygankov, D. S., 24386.
Tucker, E. L., 23270.
Tucker, W. A., 22837.
Tuckman, J., 22780, 23338, 23339, 24751, 24752.
Tulippe, O., 22813.
Tumen, H. J., 22450.
Tunkelo, A., 23394.
Turco, G. L., 22321.
Turkey. Istatistik Umum Müdürlügü, 22814.
Turnbull, E. P., 23668.
Turner, R. H., 24789.
Turpin, R., 22315.
Turunen, M., 23123.
Tuttle, S. G., 23662.
Tyce, G. M., 24346.
Tyhurst, J. S., 24233.
Tyler, M., 23944.
Tymms, P., 23099.

**U**

Uemura, K., 23621.
Ugalde, A. A., 24412.
Uhlig, H. G., 24387.
Uhlmann, E. M., 22710.
Ulissova, T. N., 23756.
United Nations, 23493.
United Nations. Department of Economic and Social Affairs, 23396.
United Nations. Economic Commission for Europe, 24212.
United Nations. General Assembly, 22815.
United Nations. Statistical Office, 22816.
United Nations. Trusteeship Council. Committee on Rural Economic Development of the Trust Territories, 22817.
U. S. Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds, 22919.
U. S. Bureau of the Census, 22818, 23397, 24196, 24197, 24198, 24199, 24200.
U. S. Congress. Senate. Committee on Labor and Public Welfare, 23467.
U. S. Department of Commerce. Bureau of the Census, 24213, 24235, 24829.
U. S. Department of Health, Education and Welfare. Office of Education, 22864, 22865.
U. S. Department of Health, Education and Welfare. Public Health Service, 22897, 23271, 24705, 24706, 24758.
U. S. Department of Health, Education and Welfare. Public Health Service. Division of Public Health Methods, 23304, 23812, 24256.
U. S. Department of Health, Education and Welfare. Public Health Service. National Office of Vital Statistics, 22270, 22271, 22515, 22999, 23000, 23475, 24400, 24402, 24830.
U. S. Department of Health, Education and Welfare. Social Security Administration, 22842, 22920, 22950, 23305, 24290.
U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance, 23418, 23428, 24834, 24844.

U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance. Division of Program Analysis, 23419, 24094, 24214, 24765, 24775, 24835, 24836.
U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Old-Age and Survivors Insurance. Division of Program Analysis. Actuarial Branch, 24707.
U. S. Department of Health, Education and Welfare. Social Security Administration. Bureau of Public Assistance, 24304.
U. S. Department of Health, Education and Welfare. Social Security Administration. Division of the Actuary, 23398, 24291.
U. S. Department of Health, Education and Welfare. Social Security Administration. Division of Program Research, 22843, 22886, 22921, 24257, 24790, 24815, 24816.
U. S. Department of Health, Education and Welfare. Special Staff on Aging, 23443, 24236, 24828.
U. S. Department of Labor. Bureau of Employment Security, 24776.
U. S. Department of Labor. Bureau of Labor Statistics, 22844, 23420.
U. S. Department of Labor. Public Employment Service, 24215, 24216.
U. S. Department of Labor. Women's Bureau, 22968, 23422.
U. S. Library of Congress. Legislative Reference Service, 23444.
University of Michigan. Division of Gerontology, 24274.
Uricchio, J. F., 23757.
Ushiro, C. S., 23163.
U.S.S.R. TSentral'noe Statisticheskoe Upravlenie, 23395.
Utterström, G., 23001.

V

Vaeth, J. P., 24588.
Valencia, R. M., 22459.
Valente, G., 23149.
Valentin, H., 22742, 23738, 24127.
Valitova, M. S., 23704.
Valk, W. L., 22604.
Vallery-Radot, P., 22503.
Valli, P., 23114.
Van Arsdol, M. D, Jr., 24761.
Van Demark, R. E., 23179.
van der Horn, I. J., 24362.
Vandow, J. E., 23295.
van Heyningen, R., 23945.
Van Huss, W. D., 23174.
van Iersel, P., 23946.
Van Liere, E. J., 23090.
Van Mechelen, M. F., 22819.
Vannier, J., 23285.
Vannini, P., 23705.
van Pilsum, J. F., 23817.
Vanslype, J. M., 22576, 22577.
Van Syckle, C., 22314.
Vantsian, E. N., 23710.
van Zonneveld, R. J., 22983, 23265, 23563, 23564, 23565, 23566, 23567, 23595, 24013, 24014, 24017, 24246, 24247, 24258, 24753.
Vargas Basurto, F. R., 23197.
Vasileva, N. N., 23992.
Vaughan, J., 24578.
Vaughn, A. M., 23813.
Vannini, P., 23705.
Vaz, E. J., 22970.
Vecchi, G. P., 23653.
Venditti, J. M., 24565.
Verge, J., 23128.
Vermeulen, A., 24513.
Vernier, C. M., 22195.
Vernon, J., 24435.
Vernon, S., 22384, 23999.
Verzár, F., 22288, 22385, 22979, 23101, 23570, 24493, 24494, 24495.
Vetter, A., 23340.
Vetukhiv, M., 22984.
Véziris, C. D., 22427, 22428.
Vianco, R., 23924.
Vickers, H. R., 23233.
Viikari, S., 23123.
Villa, A. M., 22356.
Villamayor, R. D., 24117.
Villari, V., 23924.
Villiaumey, J., 22586.
Vincent, G., 23128.
Vine, S. M., 22588.
Vinel, P., 23950.
Vischer, A. L., 24754.
Vitali-Mazza, L., 22607.
Viti, M., 23225.
Vivrett, W. K., 22209.
Vogl, A., 23315.
Volovik, M. P., 24347.
Volpe, E., 22529.
Volterrani, U., 24585, 24586.
Von Deschwanden-Müller, B., 24713.
Von Reis, G., 23711.
Voûte, P. A., 23571.
Voutilainen, A., 23218.
Vrbova, G., 23818.

W

Wadsworth, J. A., 23210.
Waife, S. O., 23659, 23663.
Waisman, M., 22595.
Wakisaka, I., 24505.
Wall, J. A., 23129.
Wallach, S., 23964.
Wallerström, B. G., 24131.
Walsh, J. E., 23002.
Walter, H., 24462.
Walter, K., 22429.
Walter, P. D., 22861.
Walter, W. A., 24403.
Walton, D., 22691.
Wang, I., 22504, 23023, 23717.
Wang, K. C., 24132.
Wanklin, J. M., 23341.
Wanner, H., 23088.
Wanner, R. L., 24428.
Warner, R., 22712.
Warnick, K. P., 23966.
Warren, J. M., 22530.
Warren, M., 23272.
Waschke, G., 22430
Washington (D.C.). Federal Council on Aging, 22210, 24326.
Washington (D.C.). Federal Housing Administration, 22874, 22875.
Washington (D.C.). Housing and Home Finance Agency, 22876.
Washington (D.C.). Statistical Society, 23003.
Watanabe, K., 24808.
Watanabe, R., 23130, 23131, 23132.
Watkin, D. M., 23032.
Watson, A. I., 22665.
Watson, M. L., 24623.
Waxman, B., 23399.
Wayner, J. J., Jr., 24548.
Weaver, N. K., 23423.
Webb, C., 24449.
Webber, I. L., 22904, 23494.
Weber, G., 23732, 23733.
Weber, G. F., 23063.
Weber, R. D., 23229.
Webster, D., 22457.
Weig, E., 23998.
Weil, P. G., 22877.
Weil, T. P., 24817.
Weill-Hallé, L., 22431.
Weinhouse, S., 23659.
Weinmann, J. P., 23213.
Weinreb, M. M., 23145.
Weinstein, L., 22505.
Weiss, H. S., 22374.
Weiss, M. M., 22378.
Weiss, M. M., Jr., 22378.
Welch, S. F., 24696.
Welford, A. T., 23572, 24755.
Wellens, P., 22578.
Weller, C. V., 22715, 22719.
Wells, A. F., 22295.
Wells, B. B., 22561.
Wells, S. M., 23211.
Welti, H., 23146.
Wenger, P., 24708.
Wenkam, N. S., 23640.
Werner, H., 24522.
Wershow, H. J., 24845.
Wertheimer, E., 23180.
Wertheimer, H., 22316.
Weschler, C. H., 22195.
Westergren, A., 23917.
Weston, D. G., 22470.
Westropp, C., 24687.
Wheeler, J R., 24610.
White, M. S., 23813.
White, N. L., 23947.
White, P. D., 22379, 22615, 23181.
Whitehead, W. F., 24447.
Whiteman, M., 22781.
Whitfield, A. G. W., 23065, 23589, 23739, 24056, 24057.
Whittier, J. R., 23622, 23689.
Widdowson, E. M., 22456, 23664.
Widstam, T., 24217.
Wied, G. L., 22432.
Wiedemann, H. R., 22220.
Wiedermann, G., 23677.
Wieriepaeva, I. S., 24549.
Wigdor, B. T., 24030, 24757.
Wiggins, A D., 23698.
Wilansky, D. L., 23788.
Wilhelm, S., 24348.
Wilkerson, W. W., Jr., 23948.
Wilkinson, C. F., Jr., 23647.
Will, G. M., 23584.
Will, L., 23139.
Willett, N. P., 24532.
Williams, B., 23068.
Williams, D., 23622.
Williams, F. M., 22593.
Williams, G., 23468.
Williams, G. C., 23671.
Williams, J. O., 24000.
Williams, J. U. (Mrs.), 22934.
Williams, M., 22720, 24687.
Williams, P. L., 23821.
Williams, V. R., 24388.
Williams, W. L., 24431.
Williams, W. S., 22721, 24095.
Willingham, W. W., 24756.
Willner, I., 23918.
Wilson, G. M., 23273.
Wilson, M. G., 22380.
Wilson, R. L., 24305.
Wilson, W., 22211.
Wilson, W. L., 23682.
Wimer, R. E., 24757.
Winfield, G. A., 22285, 23623, 24096.
Winkler, G. E., 24165.
Winn, J. F., 24696.
Winston, J. S., 22971.
Winter, M. D., Jr., 24550.
Witham, A. C., 22666, 22667.
Withrow, A. P., 23585.
Wittson, C. L., 23302.
Woessner, J. F., Jr., 24489.
Wöstmann, B. S. J., 24533.
Wolbarsht, M. L., 24389.
Wolf, R., 22419.
Wolfbein, S. L., 23424.
Wolfe, H. R., 23169, 23890, 24587.
Wolff, H., 23949.
Wolff, J. B., 23585.
Wolff, K., 23274, 24097.
Wolford, J. A., 22712.
Wood, C., 23779.
Woodford-Williams, E., 22457.
Woodhall, B., 22272.
Woods, J. H., 22938.
Woolf, B., 23870.
Woolsey, T. D, 23613.
Wray, R. P., 24292.
Wright, C. R., 24831.
Wright, E. T., 23991, 24638.
Wright, I. S., 23095.
Wünscher, W., 22480.
Wüstinger, G., 24349.
Wyler, J., 22516.
Wynroe, R. F., 22212.

Y

Yamakawa, K., 23030, 24476.
Yamamura, Y., 24390.
Yano, N., 24505.
Yapp, W. B., 22213.
Yockey, H. P., 24446.
Yokota, F., 24411.
Yoshimasu, M., 24808.
Yoshitoshi, H., 24406.
Young, A. N., 22882.
Young, A. W., Jr., 24639.
Young, J. G., 22335.
Youngblood, V. H., 22608, 24000.
Yourkovski, N., 23605.
Yudaev, N. A., 23789.
Yugoslavia. Slovenia. Zavod za Statistiko, 22908.
Yuriev, V. A., 23820.

Z

Zacco, M., 23133.
Záček, A., 23624, 23625.
Zaitseva, G. N., 23606.
Zalla, M., 24166.
Zampi, G., 23733.
Zanker, A., 24114.
Zanussi, C., 24463.
Zappia, M., 22531.
Zatzkin, H. R., 23901.
Zavattaro, D. N., 23033.
Zdansky, E., 22381.
Zecchino, V., 23969.
Zeh, W., 24709.
Zeman, F. D., 23072, 23454, 24144.
Zensser, H. H., 22359.
Zerny, C. J., 22433.
Zhukova, S. W., 23675.
Ziegler, G., 22451.
Zilli, A., 24681.
Zimmerman, K., 22452.
Zimmerman, L. E., 22557
Zintek, S. S., 22195.
Zipkin, I., 22458.
Zisser, R. L., 23635.
Zubizarreta, J., 22722.
Zwerling, I., 24163.

# Index to Volume 13

The page numbers of all original articles published in the Journal of Gerontology are set in bold face type.


A

ADLER, M.—History of Gerontological Society, Inc. 94.

AMERICAN SOCIETY FOR THE AGED, INC. 52.

B

BALFOUR, W. M.—(See Samson, F. E., Jr.)

BARROWS, C. H.—N. W. Shock and B. F. Chow. Age Differences in Cholinesterase Activity of Serum and Liver. **20.**

—M. J. Yiengst and N. W. Shock. Senescence and the Metabolism of Various Tissues of Rats. **351.**

BARRY, M.—Assessment of Community Services as Seen by a Community Welfare Council. Supp. 2. **64.**

BENSUSAN, H. B.—Does Connective Tissue Age? Supp. 2. **13.**

BERRY, R. J.—(See Grunt, J. A.)

BIRREN, J. E.—Preface. Supp. 1. 1.

—Preface. Supp. 2. 1.

—and H. Kay. Swimming Speed of the Albino Rat: I. Age and Sex Differences. **374.**

—(Also see Kay, H.)

BLUMENTHAL, H. T.—J. P. Vaeth and S. D. Soule. Effect of Non-ovarian Hormones on the Endometrium of Castrate Guinea Pigs. **261.**

—(Also see Yu, S. Y.)

BOOKS RECEIVED—184, 209, 315, 427.

BOOK REVIEWS—

A Classified Bibliography of Gerontology and Geriatrics: Supplement One, 1949-1955 (J. E. Anderson). 314.

Ageing in Industry (H. Meltzer). 315.

Aging in the Modern World, Vol. I: A Handbook for Group Members (D. P. Kent). 207.

Brightening the Senior Years (Eds.). 209.

Cardiovascular Rehabilitation (J. M. Steele). 183.

Ciba Foundation Colloquia on Ageing (A. C. Upton). 183.

Current Social Research: An Inventory (Eds.). 209.

Employment of Older Women: An Annotated Bibliography (Eds.). 209.

Free Time: Challenge to Later Maturity (M. Kaplan). 426.

Hospital Patient Survey: An Evaluation of the Basic Characteristics, Medical Findings and Potential Disposition of the Patients in the New York Municipal Hospital System with Special Reference to the Problems of Chronic Disease and Custodial Care (M. Fraenkel). 207.

Mobilizing Resources for Older People (C. Tibbitts). 82.

Older People and the Industrial Community. (J. Hammerman). 209.

Psychological Development Through the Life Span (D. C. Charles). 82.

Services for the Aging (M. J. Mack). 426.

The Aged in American Society (E. Shanas). 314.

The Chronically Ill (J. Hammerman). 208.

The News Frontiers of Aging (R. Albrecht). 208.

Trends in Gerontology (J. E. Anderson). 314.

BOTWINICK, J.—J. F. Brinley and J. S. Robbin. Task Alternation Time in Relation to Problem Difficulty and Age. **414.**

BOUCEK, R. J.—N. L. Noble, K-Y. T. Kao, and H. R. Elden. The Effects of Age, Sex, and Race Upon the Acetic Acid Fractions of Collagen. **2.**

BOURLIÈRE, F.—The Comparative Biology of Aging. Supp. 1. **16.**

BRANDSTRUP, N.—(See Kirk, J. E.)

BRINLEY, J. F.—(See Botwinick, J.)

BRITTON, J. H.—Assessment of Services for the Aged in Rural Communities. Supp. 2. **67.**

BROMLEY, D. B.—Some Effects of Age on Short Term Learning and Remembering. **398.**

BUCK, C.—(See Wanklin, J. M.)

BURGESS E. W.—L. G. Corey, P. C. Pineo, and R. T. Thornbury. **203.**

C

CHOW, B. F.—(See Barrows, C. H., Jr.)

CLARK, J. W.—(See Mangan, G. L.)

COMFORT, A.—The Longevity and Mortality of Thoroughbred Mares. **342.**

COREY, L. G.—(See Burgess, E. W.)

D

DAHL, N. A.—(See Samson, F. E., Jr.)

DRAPER, H. H.—and C. Lowe. Physiologic Aspects of Aging. II. Radiocyanocobalamin Absorption and Protein Digestion by the Rat. **252.**

DUFFY, M. L.—(See Hellbaum, A. A.)

DURY, A.—and L. D. Moss. Effect of Small Doses of Cortisone on Lipid Metabolism and Retardation of Atherosclerosis: Probable Mechanism of Action. **144.**

DYRBYE, M.—J. E. Kirk and I. Wang. Mucopolysaccharides of Human Arterial Tissue. III. Separation of Fractions by Paper Electrophoresis. **149.**

—(Also see Kirk, J. E.)

E

Egener, K. M.—(See Wanklin, J. M.)

Elden, H. R.—(See Boucek, R. J.)

Elder, J. H.—(See Olsen, I. A.)

Everitt, A. V.—and C. Webb. Blood Picture of the Aging Male Rat. **255.**

F

Farr, L. E.—A Look at Atomic Medicine in Geriatrics. Supp. 2. **27.**

FEINBLATT, H. M.—A New Tranquilizing Soporific for Insomnia—The Value and Safety of Methapyrilene and Scopolamine in Combination. **48.**

FITCH, W. C.—Assessment of Services in the Public Agency Field as Seen by a Federal Department. Supp. 2. **62.**

FRIEND, C. M.—and J. P. Zubek. The Effect of Age on Critical Thinking Ability. **407.**

FULLER, C. A.—(See Strong, L. C.)

G

GABAY, S.—(See Sobel, H.)

GEILL, T.—Clinical Investigations on Aging Published in Europe After the Second World War. Supp. 1. **25.**

GERIATRIC PRACTICE—**177.**

GITMAN, L.—T. Kamholtz and J. Levine. Osteoporosis in the Aged. Radiographic Survey with Clinical and Biochemical Correlations. **43.**

GOLDFARB, A. I.—(See Pollack, M.)

GOLDSCHMIDT, L.—and J. R. Whittier. Increase in N, N-Dimethyl-P-Phenylenediamine (DPP) Oxidase Possibility with Aging in Mental Patients. **132.**

GRUNT, J. A.—R. J. Berry and W. H. Knisely. Effects of Castration and/or Hormonal Therapy upon the Hematocrit in Aged Male Rats. **359.**

H

HAMILTON, J. B.—H. Terada and G. E. Mestler. Studies of Growth Throughout the Life Span in Japanese: II. Beard Growth in Relation to Age, Sex, Heredity, and Other Factors. **269.**

HANLEY, T. D.—(See Mysak, E. D.)

HAVIGHURST, R. J.—A World View of Gerontology. Supp. 1. **2.**

HEILBRUNN, L. V.—Colloidal Changes in Aging Cells. Supp. 2. **2.**

HELLBAUM, A. A.—W. K. Ishmael, M. L. Duffy, and R. W. Payne. The Effect of Estrogen, Androgen, and Thyroid in Degenerative Joint Disease. **163.**

HERZBERG, F.—Relationship of Age to Pain in Dental Operative Procedures with Rotating Instruments. **167.**

HOBBS, G. E.—(See Wanklin, J. M.)

I

INDEX TO CURRENT PERIODICAL LITERATURE. 103, 216, 318, 455.

ISHMAEL, W. K.—(See Hellbaum, A. A.)

K

KAHN, R. L.—(See Pollack, M.)

KAMHOLTZ, T.—(See Gitman, L.)

KAO, K-Y. T.—(See Boucek, R. J.)

KAPLAN, M.—Pressures of Leisure on the Older Individual. Supp. 2. **36.**

KAY, H.—and J. E. Birren. Swimming Speed of the Albino Rat: II. Fatigue, Practice, and Drug Effects on Age and Sex Differences. **378.**
—(Also see Birren, J. E.)

KHEIM, T.—(See Pauker, J. D.)

KIRK, J. E.—I. Wang and M. Dyrbye. Mucopolysaccharides of Human Arterial Tissue. IV. Analysis of Electrophoretically Separated Fractions. **362.**
—J. R. Matzke, N. Branstrup, and I. Wang. The Lactic Dehydrogenase, Malic Dehydrogenase, and Phosphoglucoisomerase Activities of Coronary Artery Tissue in Individuals of Various Ages. **24.**
—(Also see Dyrbye, M.)

KNISELY, W. H.—(See Grunt, J. A.)

KOHN, R. R.—and E. Rollerson. Relationship of Age to Swelling Properties of Human Diaphragm Tendon in Acid and Alkaline Solutions. **241.**

KOUNTZ, W. B.—(See Pauker, J. D.)

KRAL, V. A.—Neuro-Psychiatric Observations in an Old Peoples Home. Studies of Memory Dysfunction in Senescence. **169.**

L

LANDOWNE, M.—The Relation Between Intra-Arterial Pressure and Impact Pulse Wave Velocity with Regard to Age and Arteriosclerosis. **153.**

LARSSON, K.—Sexual Activity in Senile Male Rats. **136.**

LEHMAN, H. C.—The Influence of Longevity Upon Curves Showing Man's Creative Production Rate at Successive Age Levels. **187.**

LEVINE, J.—(See Gitman, L.)

LICHTENSTEIN, I.—(See Sobel, H.)

LOVELACE, F.—L. Will, G. Sperling, and C. M. McCay. Teeth, Bones, and Aging of Syrian Hamsters. **27.**

LOWE, C.—(See Draper, H. H.)

M

MACK, M. J.—An Evaluation of a Retirement-Planning Program. **198.**

MAGLADERY, J. W.—R. D. Teasdall and A. H. Norris. Effect of Aging on Plantar Flexor and Superficial Abdominal Reflexes in Man—A Clinical and Electromyographic Study. **282.**

MANGAN, G. L.—Method-of-Approach Factors in the Testing of Middle-Aged Subjects. **55.**

MASTERS, Y. F.—(See Stidworthy, G.)
—and James W. Clark. Rigidity Factors in the Testing of Middle-Aged Subjects. **422.**

MATHIASEN, G.—Assessment of Services in the Voluntary Agency Field as Seen by a National Committee. Supp. 2. **58.**

MATZKE, J. R.—(See Kirk, J. E.)

MCCAY, C. M.—(See Lovelace, F.)

MCCONNELL, J. W.—The Impact of Aging on the Economy. Supp. 2. **42.**

MELTZER, H.—Age Differences in Work Attitudes. **74.**

MENSH, I. N.—(See Pauker, J. D.)

MESTLER, G. E.—(See Hamilton, J. B.)

MONTOYE, H. J.—(See Pierson, W. R.)

MOSS, L. D.—(See Dury, A.)

MYSAK, E. D.—and T. D. Hanley. Aging Processes in Speech. Pitch and Duration Characteristics. **309.**

N

NELSON, N. H.—(See Sobel, H.)

NOBLE, N. L.—(See Boucek, R. J.)

NORRIS, A. H.—(See Magladery, J. W.)

O

OLSEN, I. A.—and J. H. Elder. A Word-Association Test of Emotional Disturbance in Older Women. **305.**

ORGANIZATION SECTION. 86, 212, 430.

P

PAUKER, J. D.—T. Kheim, I. N. Mensh, and W. B. Kountz. Sex Hormone Replacement in the Aged. I. Psychological and Medical Evaluation of Administration of Androgen-Estrogen Combined with Reserpine. **389.**

PAYNE, R. W.—(See Hellbaum, A. A.)

PESZCZYNSKI, M.—Geriatric Practice: Contractures of the Involved Extremities of the Hemiplegic Adult. **177.**

PIERSON, W. R.—and H. J. Montoye. Movement Time, Reaction Time, and Age. **418.**

PILGERAM, L. O.—Deficiencies in the Lipoprotein Lipase System in Atherosclerosis. **32.**

PINEO, P. C.—(See Burgess, E. W.)

POLLACK, M.—R. L. Kahn and A. I. Goldfarb. Factors Related to Individual Differences in Perception in Institutionalized Aged Subjects. **192.**

POLLAK, O. J.—Combined Beta-Sitosterol and Linoleic Acid Regimen for Cholesterol-Fed Rabbits. **140.**

R

ROBBIN, J. S.—(See Botwinick, J.)

ROCKSTEIN, M.—Heredity and Longevity in the Animal Kingdom. Supp. 2. **7.**

ROLLERSON, E.—(See Kohn, R. R.)

S

SAMSON, F. E., Jr.—W. M. Balfour and N. A. Dahl. Effect of Age and Temperature on the Cerebral Energy Requirement in the Rat. **248.**

SCOTT, F. G.—Intrastate Migration of the Pre-Aged and the Aged in Texas. 1935-1940. **296.**

SHETLAR, M. R.—(See Stidworthy, G.)

SHOCK, N. W.—Author Index to Current Periodical Literature. 474.

—Index to Current Periodical Literature. 103, 216, 318, 455.

—(Also see Barrows, C. H., Jr.)

SIMONSON, E.—Functional Capacities of Older Individuals. Supp. 2. **18.**

SOBEL, H.—S. Gabay, E. T. Wright, I. Lichtenstein, and N. H. Nelson. The Influence of Age Upon Hexosamine-Collagen Ratio of Dermal Biopsies from Men. **128.**

SOULE, S. D.—(See Blumenthal, H. T.)

SPERLING, G.—(See Lovelace, F.)

STIDWORTHY, G.—Y. F. Masters, and M. R. Shetlar. The Effect of Aging on Mucopolysaccharide Composition of Human Costal Cartilage as Measured by Hexosamine and Uronic Acid Content. **10.**

STREICHER, E.—Age Changes in the Calcium Content of Rat Brain. **356.**

STRONG, L. C.—and C. A. Fuller. Maternal Age at Time of First Litters in Mice. **236.**

T

TEASDALL, R. D.—(See Magladery, J. W.)

TERADA, H.—(See Hamilton, J. B.)

THORNBURY, R. T.—(See Burgess, E. W.)

TIBBITTS, C.—The Impact of Aging on Social Institutions. Supp. 2. **48.**

TONNA, E. A.—Histologic and Histochemical Studies on the Periosteum of Male and Female Rats at Different Ages. **14.**

TUCKMAN, J.—The Projection of Personal Symptom into Stereotype About Aging. **70.**

V

VAETH, J. P.—(See Blumenthal, H. T.)

VAN ZONNEVELD, R. J.—Gerontologic Research Activities of the Organization for Health Research T. N. O. in the Netherlands. 453.

—Public Health and the Aged in Europe: Research and Programs. Supp. 1. **67.**

VERZÁR, F.—Problems of General Biology of Aging. Supp. 1. **6.**

W

WANG, I.—(See Dyrbye, M., and Kirk, J. E.)

WANKLIN, J. M.—K. M. Egener, C. Buck, and G. E. Hobbs. A Comparative Study of Elderly Mental Hospital Patients and Residents of Homes for the Aged. **60.**

WEBB, C.—(See Everitt, A. V.)

WELFORD, A. T.—Psychological and Social Gerontology in Europe. Supp. 1. **51.**

—The Assessment of Mental and Social Health in Relation to Age. Supp. 2. **32.**

WHITTIER, J. R.—(See Goldschmidt, L.)

WIGDOR, B. T.—(See Wimer, R. E.)

WILL, L.—(See Lovelace, F.)

WIMER, R. E.—and B. T. Wigdor. Age Differences in Retention of Learning. **291.**

WINSTON, E.—Assessment of Community Welfare Programs for the Aged. Supp. 2. **53.**

WRIGHT, E. T.—(See Sobel, H.)

Y

YIENGST, M. J.—(See Barrows, C. H., Jr.)

YU, S. Y.—and H. T. Blumenthal. The Functional Significance of Mucopolysaccharide Obtained from Cattle Aorta. **366.**

ZUBEK, J. P.—(See Friend, C. M.)

# Experimental Research into Problems of Ageing

THE TRUSTEES of the

CIBA FOUNDATION

*for the Promotion of International Co-operation in Medical and Chemical Research*

41 PORTLAND PLACE, LONDON, W.1

wishing to encourage well-conceived research relevant to basic problems of ageing, invite candidates to submit papers descriptive of work in the field for *the fifth and final annual*

## AWARDS for 1959

*Copies of the Regulations and Form of Application must be obtained from the undersigned before an entry is submitted,* but in general candidates should note:—

(*a*) Not less than five awards, of an average value of £300 each, are available for 1959. The announcement of awards will be made in August 1959.

(*b*) Entries must be received by the undersigned not later than 10th January, 1959.

(*c*) Entries will be judged by an international panel of distinguished scientists including: Prof. C. H. Best (Toronto), Prof. E. Braun-Menendez (Buenos Aires), Prof. E. J. Conway (Dublin), Prof. G. W. Corner (New York), Prof. A. Haddow (London), Prof. V. R. Khanolkar (Bombay), Prof. R. Nicolaysen (Oslo), Dr. A. S. Parkes (London), Prof. F. Verzár (Basle), and Prof. F. G. Young (Cambridge). They will advise the Executive Council of the Foundation on their findings and will also have power to recommend variation in the size and number of the awards according to the standard of entries. The decisions of the Executive Council will be final.

(*d*) In making the awards preference will be given younger workers.

(*e*) The papers may be in the candidate's own language. Papers should not be more than 7,000 words in length and in all cases a summary in English not exceeding in words 3% of the length of the paper must be attached. If possible, 10 copies of reprints in English should be provided.

(*f*) Where there is one or more co-author, name of the leading author should be indicated; it is to him that the award will normally be made, and it will be left to his discretion to share this award appropriately with his co-authors.

G. E. W. WOLSTENHOLME
*Director,*
*and Secretary to the Executive Council.*

# JOURNAL OF GERONTOLOGY

SUPPLEMENT No. 1

## Special Symposium: A Survey of European Gerontology*

## Presented at the Tenth Annual Meeting of Gerontological Society, Inc.

## Cleveland, October 31, 1957

PREFACE ..... JAMES E. BIRREN 1

A WORLD VIEW OF GERONTOLOGY ..... ROBERT J. HAVIGHURST 2

PROBLEMS OF GENERAL BIOLOGY OF AGING ..... F. VERZÁR 6

THE COMPARATIVE BIOLOGY OF AGING ..... F. BOURLIÈRE 16

CLINICAL INVESTIGATIONS ON AGING PUBLISHED IN EUROPE AFTER THE SECOND WORLD WAR ..... TORBEN GEILL 25

PSYCHOLOGICAL AND SOCIAL GERONTOLOGY IN EUROPE ..... A. T. WELFORD 51

PUBLIC HEALTH AND THE AGED IN EUROPE: RESEARCH AND PROGRAMS ..... R. J. VAN ZONNEVELD 67

* Symposium and publication of this supplement made possible by a grant (H-3195) from the National Institutes of Health.

# PREFACE

The papers which follow were presented at a special symposium held in Cleveland, Ohio, October 31, 1957, during the annual meeting of the Gerontological Society. The purpose of the symposium was to survey current European research in gerontology and to point out developments and trends in research methods, types of problems, and theory. We were pleased to invite our experienced and talented European colleagues to participate in the symposium and to prepare these reviews. There were many others whom we would like to have been able to invite to join this distinguished panel; one of the most difficult tasks of arranging the symposium was that of reducing the number of possible qualified persons to a small group to represent many specialties and countries. We might be asked why we chose only to invite European gerontologists. This was done not out of prejudice but because European gerontologists are more organized and hence more "visible" than those in other parts of the world and also because their experiences seemed most pertinent for the United States. Because of similarities in origins, social customs, and age structure of the population, it seemed useful as an initial venture to summarize trends in European gerontology. However, we would be open to criticism if in the future we do not also seek information exchanges with individuals from other countries and continents. Not only by reviewing similarities of experience but also by studying contrasts can we learn what is essential and crucial in gerontology.

These reviews of gerontology are regarded as so significant that they are printed in this special edition to bring them to the attention of those who did not have the opportunity of hearing them in Cleveland and for those who heard the symposium but wanted to read the papers in detail. The reviews are scholarly and authoritative and bring to our attention literature and issues we might otherwise miss. As scholars, these authors are deeply involved in their subject matter, yet their objectivity and detachment, so necessary in science, does not make them unmindful or unfeeling of the problems of aging individuals.

Supported by a grant, H-3195, from the National Institutes of Health.

This was a multidisciplinary symposium with representatives from the biologic sciences, clinical medicine, psychologic and social sciences, and public health and welfare. Planning of the symposium gave emphasis not only to intensive reviews of the special areas but also encouraged breadth of content, for at this time no one quite knows the relative importance of the disciplines, or if they are relevant or irrelevant to aging. What logically constitutes gerontology is an emergent topic and we can facilitate discussion by free exchanges of information of the sort represented by this symposium. In time we will undoubtedly know how the disciplines interrelate in gerontology, but at the moment the wise course seems to be to set side by side the thinking and facts of the various scientific and professional disciplines.

As man grows older his probability of death increases, associated perhaps with some general factor still obscure, but contrasting views may not be dismissed without more facts. One might conceive of an individual man or organism as a universe with many subsystems, each subsystem having the potential to terminate the existence of the whole but largely autonomous of the others. Some subsystems could have time courses so different from the mean of the whole organism as to be largely irrelevant to considerations of aging. How the systems of the organism interrelate in aging is one of the core problems of gerontology awaiting experiment and fact. What may be left after biologic, social, and psychologic pathology is explained or removed may be small, yet this residual or age variance whether large or small may be of profound significance for our thinking about the nature of the organism. It is not pretentious to think that serious pursuit of gerontology will have dramatic consequences for man's well-being and actions. Clearly, this symposium is another promising child of gerontology, born of the good intellectual parentage of the participants. The program committee is proud to have assisted the participants in the 'delivery' and it anticipates a vigorous and productive future for the offspring.

*James E. Birren*
Program Chairman, 1957

# A WORLD VIEW OF GERONTOLOGY

ROBERT J. HAVIGHURST, Ph.D.

*(From the University of Chicago. President of the Gerontological Society)*

Gerontology as a special branch of science is very young, though it has roots which reach far back into the history of medicine. I do not propose to go into the past but rather to examine the present status and the prospects of gerontology in the United States and other countries.

A product of the efflorescence of science in the twentieth century, modern gerontology started in this country about twenty years ago, when a small group of physicians, biologists, and sociologists formed the Club for the Study of Aging. Similar groups were forming in Europe, and soon an International Association of Gerontology was organized. This association has held four international meetings, and a Pan-American Congress of Gerontology met in Mexico City in 1956.

Gerontology is both an applied and a pure science. As an applied science it utilizes our knowledge of aging to make life longer and more satisfying. As a pure science it seeks knowledge about the aging of animals and men, both individually and in population aggregates.

The pure science of gerontology has been carried on wherever scientists have had time enough and resources enough to follow their own curiosity without having to solve some pressing practical problem. Thus we have had studies of the physiology, anatomy, and biochemistry of aging cells; of longevity in relation to diet; of the learning abilities of rats and of men in relation to their age; of changes of attitudes with age; and of the aging of human populations. In general, the pure-science aspects of gerontology have been produced by scientists of Europe and North America.

Work in applied gerontology is more widespread than work in pure gerontology. Applied gerontology appears wherever there is a problem that involves aging. Some of it is hardly science at all but is merely the application of common sense and human sympathy to problems of aging. The field of applied gerontology can conveniently be divided into two parts: medical and social. Each of these parts has three aspects, or stages of development. (We are seeking to look at gerontology in its broad features, without any attempt at historical balance, and consequently we shall not attempt to trace these stages of development in detail.)

Medical gerontology includes: 1) treatment of the elderly patient, 2) prevention of disease and disability in the elderly, and 3) preservation of vigor in the elderly. Social gerontology considers: 1) financial support of the elderly, 2) housing and living arrangements of the elderly, and 3) ego-support of the elderly.

## MEDICAL GERONTOLOGY

The first stage of medical gerontology, treatment of the elderly patient, is as old as the profession of medicine, but some of the twentieth-century developments make this as much a growing edge of science as are the later stages. Antibiotics have so reduced mortality that the chances of recovery from pneumonia and certain other infectious diseases have been multiplied many fold. Furthermore, the attitude of the medical profession toward surgery for aged patients has changed drastically. A patient of eighty or even ninety years is now regarded as a good risk for surgery, provided his general physical condition can be built up through diet and rest. No doubt most of us will live to see further major advances, such as a cure for cancer.

The second stage of medical gerontology, prevention of disease and disability, is essentially a twentieth century product. The early detection and treatment of cancer is its greatest triumph. Perhaps coronary heart disease and hypertension will be conquered in our lifetime. The multiple screening programs of some of the great clinics have demonstrated that lives can be saved on a broad scale by systematic screening of groups of people in late middle age. Another important development in this area is the application of physical medicine to the rehabilitation of persons who have suffered strokes and fractures.

The latest stage is the *positive* approach to physical aging, the attempt to help people preserve their full adult vigor as long as possible. The means used will probably be diet, supplemented perhaps by hormone and vitamin therapy. It is here that the medical scientists will make their greatest contribution to the basic aim of gerontology—to add life to the years.

Development of medical gerontology in the second and the third stages is discussed by Dr. Halbert L. Dunn, chief of the National Office of Vital Statistics, United States Public Health Service, who uses the concept of "positive health" to describe the attempt of society to help people achieve "high-level wellness." He says that this must be a joint project of medical and social gerontology.

## SOCIAL GERONTOLOGY

Social gerontology is much younger than medical gerontology. The only trace of social gerontology before the present century is found in the old people's homes which were established in Europe as a work of charity several centuries ago. The need for social gerontology arises when the traditional family breaks down and ceases to perform its function of caring for all the members of the family from the cradle to the grave. The transition from the traditional to the modern family was in full swing in the cities of Europe and the United States during the nineteenth century. By the end of that period it was clear that one of the major social problems resulting from this transition was the loss of economic and moral functions by the elderly members of the family.

The beginning of the first stage of social gerontology, financial support of the elderly, may be set around the year 1900, when various countries worked out old-age pension schemes. A growing population of older people was needing support because urbanization, industrialization, and family change had robbed them of their traditional means of livelihood. Society consequently devised schemes of pensions and old-age assistance, which have been extended to cover more and more older people in more and more countries. This is still a frontier sector of gerontology, as various countries experiment with, and adapt, their old-age insurance and pension programs to changing practices in retirement and to inflationary economic trends. Thus the first stage of social gerontology involved recognition of economic needs of older people and attempts to meet these needs.

The financial need was no sooner met than another need became evident, and with this came the second stage of social gerontology—consideration of the need by many elderly people for comfortable housing and living arrangements. With families and houses growing smaller, and with intrafamily attitudes changing, fewer and fewer old people could live with their children. Since many old people in the cities were not home owners, they were at a disadvantage in the competition for houses of their own and generally had to put up with the marginal housing, the least desirable. A variety of public and private housing schemes came into existence to help solve this problem, and a considerable body of expert knowledge has grown out of the experience with old people's homes, homes for infirm older people, public housing for couples and individuals, and private housing for people who can pay for good quarters. This sector of social gerontology is perhaps the most interesting today, with its variety of experiments involving architects, social workers, recreation experts, and nursing experts, as well as economists and real-estate specialists.

When these two needs for older people are reasonably well met, society discovers that there is still an unmet need, deeper and more baffling than the material needs. It is the need to be needed—the need to have a function in society, to have a respected place in the eyes of others, and to be doing something which is interesting and significant in one's own eyes. This *need for ego-support* is the province of the third stage of social gerontology.

Only a few societies have reached this third stage of social gerontology, though there are far-seeing, sensitive individuals in all societies who have discerned the need. It has been defined by the leading social gerontologists in Sweden, the country which has the keenest sense of society's responsibility for the individual and of the individual's responsibility for society. In a talk at a United Nations Conference in 1955, A. Helge Dahlström, director of the Swedish Social Welfare Office, described in one paragraph these three stages or tasks of social gerontology:

Our basis for the measures for the aged is the conception that old people should be given the

possibility to live a free and independent life to the same extent and with the same social amenities as the other age groups in society. To realize these aims it is at first necessary that old people should have financial security. . . . Furthermore and in the second place the old people must have access to good and appropriate dwellings and a social service which creates the possibilities for them to live in their own homes as long as possible. There also are to be measures which will help to make their lives pleasant and which break through the isolation from the outside world which so very easily becomes the lot of old people.

At this third stage of social gerontology it is recognized that helping old people to meet their material needs is not enough. They also need companionship, a sense of being wanted and needed by other people, and pleasant and interesting things to do in their many free hours. This is not a sentimental illusion of middle-aged people who project their own need for activity into the later years; it is a fact reported in many studies of people in their sixties and seventies. To meet these needs, a variety of devices have been developed, the most important being clubs or informal social groups of one kind or another. The activities of these senior citizens' organizations vary, from a simple monthly social meeting in a church hall or the community room of a neighborhood center, to a complex program including vacation bus tours, classes in landscape-painting, discussion groups on foreign and domestic social problems, handicraft shops, money-earning projects, and theater and concert parties.

In the development of this type of program, various kinds of organizations have been active: church groups in Holland and the United States; trade unions in Sweden; women's organizations in England and Holland; cooperative societies in Switzerland; municipal old people's welfare committees in England; organizations of senior citizens or older people in the United States, France, Holland, and Sweden; and social-welfare organizations in Germany, the United States, England, France, Sweden, and Denmark.

## SOCIAL GERONTOLOGY AND SOCIAL CHANGE

It is evident that the second and the third stages of medical gerontology are most highly developed in countries which are most urbanized and most industrialized and which have the largest proportions of older people.

This generalization applies also to social gerontology, which is most advanced in such countries as Sweden and England, and is hardly developed at all in the agricultural countries. Countries in transition toward urbanization and industrialization show the beginnings of social gerontology. For instance, when the Pan-American Congress on Gerontology met in Mexico City, a number of Mexicans presented papers in the social-gerontology field, all dealing either with Mexico's developing old-age-pension program or with old people's homes, while the papers by Americans and Canadians tended to deal with stage three of social gerontology but also to include developments at stages one and two. In Mexico, 3.5 per cent of the population is over sixty-five years of age, and the country is just beginning to become urbanized and industrialized. In Canada and the United States, over 8 per cent of the people are over sixty-five, and these countries are well into a phase of urbanization and industrialization.

Social gerontology does not exist at all, and is really not needed, in the nonindustrial, agricultural countries, with three-fifths of the world's population. It is just making its appearance in such countries as Mexico, Brazil, Russia, and South Africa, which have one-fifth of the world population. It is quite well developed and moving into the third stage in the industrial and urban countries with relatively large proportions of older people. These countries embrace another fifth of the world population.

## POPULATION FACTS AND SOCIAL GERONTOLOGY

The present and the probable future development of social gerontology and also of medical gerontology are closely related to the proportions of older people in the population and to the trends of these proportions. Figure 1 shows the trends in the proportions of people aged sixty-five and over in a number of typical countries during the past 50–100 years. These countries can be grouped as follows:

A. High proportion of older people, with rapid increases in the past one hundred years; population substantially industrial and urban: France, Great Britain, Sweden.
B. Slow increase of older population in the past one hundred years, reaching a moderately high present level; population slowly growing more urban-industrial: Germany, Switzerland.

C. Increasing proportion of older people in the past fifty years, which will reach the level of countries in Group A in the next twenty years; population rapidly growing more urban and industrial: Australia, Canada, United States.

D. Slow increase of older population in the past one hundred years, reaching a medium present level; population growing slowly more urban: Denmark, Holland, Italy, Portugal.

E. Low proportion of older people, with slow increase for the next twenty years; population mainly rural at present but growing slowly more urban-industrial: Brazil, India, Mexico.

F. Medium proportion of older people, with slight change in past fifty years; population growing slowly more urban-industrial, with high outmigration: Japan.

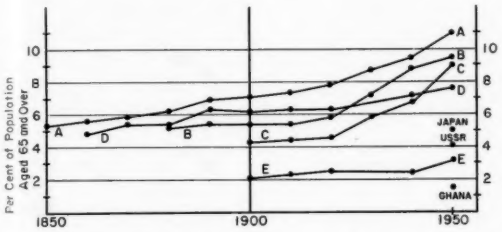


Fig. 1. Per cent of population aged sixty-five and over from 1850 to 1950 in typical countries of the world. Group A includes France, Great Britain, and Sweden; Group B, Germany and Switzerland; Group C, Australia, Canada, and United States; Group D, Denmark, Holland, Italy, and Portugal; Group E, Brazil, India, and Mexico.

Social gerontology is most fully developed in the countries of Groups A, B, C, and D, with about one-fifth of the world's population. Social gerontology is less developed in the countries of Group E, which contain another fifth of the world's population. It does not exist at all, and is not relevant to the situation, in the agricultural, nonurban and nonindustrial countries which are often called "underdeveloped."

As exceptions to the trend, certain of the countries of Groups A, B, and D have not pushed social gerontology much beyond its first stage. These exceptions are France, Italy, Portugal, and Switzerland. When compared with the other European countries, these are seen to be more rural and more Catholic, and to have stronger family institutions of the traditional kind which provide housing and ego-support for their elderly members. Even within these countries, as within mainly agricultural countries such as Brazil and Mexico and Russia, work is going on in social gerontology in the cities and industrial centers, as in Paris, Zurich, Rome, Milan, Mexico City, São Paulo, and Moscow.

## THE FUTURE OF GERONTOLOGY

From these considerations it is possible to predict the course of gerontology with assurance for the next twenty years, and with a fair probability for fifty years. The frontier developments, both in medical and in social gerontology, will occur in those countries which are most prosperous, most urban-industrial, and which have the largest proportions of older people. At the same time there will be a slow development of both second and third stages of medical and social gerontology in such countries as Brazil, India, and Mexico. In the remaining three-fifths of the world, which is essentially agricultural and nonindustrial, little gerontological activity will appear before the beginning of the twenty-first century.

The countries with the least activity in gerontology will, nevertheless, be adding years to human life during the remainder of this century; while the countries with the most activity in gerontology will be adding life to the years.

# PROBLEMS OF GENERAL BIOLOGY OF AGING

F. VERZÁR, Dr. med., Prof. emer. Physiology
*(University of Basel, Switzerland)*

This review is intended to be a comment upon trends in research and dominant themes during recent years and probable future developments of research in Europe upon the general biology of aging.

The present attitude toward experimental research on aging suffers from the mistakes which were made a generation ago, and it might therefore be interesting to consider what these were. First of all, we no longer see the aim of gerontologic research in the same way as 50 years ago. At that time the goal was the prolongation of human life. Now we have reached a state where, because of advances in hygiene and medicine, more people live to become old and the proportion of old people has thus increased to the extent that the new aim is to keep these older people in a healthy state for an enjoyable and active life. The second new point of view is that only such experiments which have scientific validity and are not based simply on subjective opinion or on one-sided observations are now acceptable; they must have all the criteria which are required in any physiologic study.

Looking back through my own time, I remember the sensational statement that the cause of aging was intoxication by intestinal bacteria. Metchnikoff, who was later a member of the Institut Pasteur, taught this concept and resorted to therapeutic measures even though no experimental proof for the theory existed. Another example is the work of Brown-Séquard, the well-known French physiologist, who gave himself injections with extract of sex glands and believed in his own rejuvenation. This theory started a great deal of experimental work which finally proved that he was mistaken. A further illustration is provided by the work of Steinach, a first-class physiologist, whose studies on respiration, circulation, and internal secretion are of high value. Unfortunately the propaganda style in which his pupils and some surgeons used his experiments discredited his work and the word rejuvenation.

Similar activities are going on at the present time. Injections are given with embryonic cells, pills containing such cellular material are even produced commercially. At present we live in the period of the Bogomoletz-serum (13), and it is more difficult to find out whether or not this has the necessary scientific foundation. It is said to be an "antireticulocyte-serum," supposed to destroy the cells of connective tissue which are claimed to be deleterious for collagen fibers. It is prepared from extracts of lymph glands and spleen. Small doses were said to be cell-stimulating and therefore dangerous. From this basis, quite a number of scientists worked on the question and produced contradictory results. It was characteristic that at the Fourth International Gerontological Congress this item was the first to get into the daily newspapers. One should, however, read Foà's (29) criticism of this work.

I have mentioned these unfortunate examples to explain why there is a reluctance on the part of many to participate in experimental gerontology and why we have to prove again and again that gerontologic research, especially experimental research on aging, is in fact justified.

Until a few years ago it was often said that the problem of aging was identical with the problem of life and that far too little basic knowledge was available to work on aging alone. The history of physiology, however, has shown that useful experimental work is also possible along lines for which we do not have the basic facts. As research continues, one may hope to reach firmer ground.

## *Some Present Problems in Experimental Gerontology*

I shall attempt to discuss some major problems of experimental gerontologic research which seem to me important at the present time. These are necessarily personal opinions, which may not coincide with the views of others.

The main lesson which I think we have gained from the fate of previous research into the process of aging is that any conclusions as to factors which are claimed to show an influence on aging can only be accepted if it can be proved scientifically that the biologic age of an individual has been influenced. We must therefore try to find satisfactory scientific tests

to measure objectively the biologic age of individual animals or persons.

The simplest method is a survival test. If survival is prolonged by a certain factor, then that factor may be said to influence the aging process. This test has, however, several drawbacks: 1) it will take years before an answer can be given. The shortest lived experimental mammals are rats and mice, which have a life expectancy of about 50 per cent at 24 months. It is often not understood that there is no such thing as a fixed life span for any known species; even from an inbred colony, individuals die off in an S-shaped curve; 2) a large number of animals is needed for each test because only then can a 50 per cent survival be exactly measured, and even larger numbers would be needed if one wants to follow the animals until all are dead. The second point means that, if rats are used, not less than 100 or 200 animals must be kept for 2 years to prove whether a 50% survival at 24 months has been influenced. Thus in spite of the fact that survival experiments are undoubtedly the best tests, they can be used only as final proof.

Similarly age tests which involve killing the animal for certain histologic or chemical investigations have the drawback of irreversibility. Obvious morphologic changes are certainly of value; the plasticity of the skin, the graying of hair, etc. might be used, but all of these are rather inexact measurements and we are searching for more exact assessment. This might be provided by functional tests.

In man, the decrease of the visual accommodation capacity, the advance of presbyopy, is still probably the best and most exact test of biologic aging. Apart from men, only monkeys could be used, since other experimental animals do not seem to have a major optical accommodation.

Actually we are utilizing this fact at present in a longitudinal research problem on man (16). We have selected 200 people from a factory in which they generally work from youth to old age, and we are studying systematically the accommodation of the eye with all modern methods, while parallel tests are made by specialists on general health with the usual clinical methods. The team consists of an ophthalmologist, an internist, a dermatologist, and a physiologist, the latter determining pulse wave velocity as a possible measurement of elasticity of the blood vessels. Our problem is to discover whether presbyopic changes run parallel with other changes, and if so, with which. This is, of course, a program for 30 or 40 years. Therefore the methods have been standardized, and we hope that the theme will go on when the present researchers will no longer be there.

I might remark that even the explanation of the primary fact, that visual accommodation decreases with age because of the decrease of elasticity of the lens, is not really settled. A distinct role is played by the tonus or the force of the ciliary muscle. It is interesting to see how this can be influenced by psychic factors, leading to astonishing changes in the visual capacity of old persons if they are brought from an old age home to a summer holiday place.

The other seemingly exact test, the measurement of pulse wave velocity, which is registered parallel with visual accommodations, certainly does register change with age, but the value of this test by itself is under discussion (52).

Bernstein (11), the famous mathematician, calculated life span from the development of presbyopy. Only a longitudinal research program can solve the question of whether this is possible. It is certainly not yet proved.

The accommodation of the eye and the changes of pulse wave velocity are functional tests. The most characteristic signs of aging are changes of adaptation, which is the general capacity of living organisms to live under continuously changing conditions. The adaptation capacity of metabolic equilibrium is probably the best characterization which can be given for "life." When this adaptability decreases, aging begins (68).

Such a point of view, of course, conflicts with the idea that aging starts with birth or even conception. Not every atrophic process is aging. The changes in ontogenetic evolution are not decreases of adaptation. On the contrary, evolution means increasing adaptation to new conditions; when the human embryo loses gills and tail, it has recapitulated a part of its adaptation from former generations to a completely changed evolutionary period. The greatest adaptation process is birth itself, when the individual is transferred to completely new life conditions. We therefore propose that problems of early evolution until puberty should not be mixed up with research on aging.

The newly born infant has to adapt himself to extra-uterine life; he now acquires heat-regulation, enteric nutrition, etc. Thus he in-

creases the range of his environment and acquires more and more potentials to meet the constantly changing conditions of life. Psychic evolution increases these possibilities still further, and the result is that man can now live in the Arctic or in the Tropics; he can fly in the stratosphere or descend 1000 meters underground.

However, from a certain age on, the adaptation capacity becomes less and less complete. This is well known for muscular efficiency in sports. The eye decreases in power of accommodation from the twelfth year on. If man lived under the conditions of wild animals, the decrease in muscular efficiency and visual accommodation would limit his lifetime to 50 years at most, because he would not see or fight his enemy in time. The limit of his life would be about the same as the reproductive life of his female partner. It is only through adaptation by psychic capacities that it is possible for man to survive longer, for only man is able to transfer the experience of a lifetime to the next generation, and to be still a useful member of society. This specific human factor of gerontology will be discussed by Welford.

I shall give you a few examples from my own laboratory of how the decrease of adaptation may or may not be used as a characteristic of aging and become a test for biologic age.

Adaptation to low temperature can be tested on rats (44). We transfer the animals to temperatures of −1, −5, −11 C. for 1 hour. Young rats at −1 C. do not change their body temperature to any marked degree, not even at −5 C. In 12-month-old animals one may, however, see individuals which have less efficient regulation, and with older animals it becomes progressively worse. At −11 C. the body temperature of young animals may drop by 2 or 3 C. and of old animals by 8 or 10 C., which may lead to death. If these changes are studied on a large enough number of animals, one finds a continuous decrease in the capacity to regulate the body temperature, but one will also find large individual differences. There are some 6-month-old animals which behave like the older ones, while there are some of 28 months which behave as if young. We do not believe that these disturbances could be explained by changes in sensitivity or changes in heat production caused by a decrease of muscular mass. It seems more probable that it is the heat regulatory center which has lost its capacity of adaptation and thus of heat regulation. I should like to remark, however, that just lately it has been shown by Wertheimer (75) that a cooled animal's surviving diaphragm has an increased glucose-metabolism only in young and not in older animals. This would mean that there are certain endocrine metabolic factors involved.

Another adaptation test uses the capacity of animals to adapt to low atmospheric pressure (27). Rats are placed in a tank and the pressure decreased to 350 mm. Hg within 30 minutes. Their rectal temperature drops 3 to 5 C. During the next 48 hours, a complete adaptation sets in, the body temperature again becomes normal (37-38 C.) in spite of the fact that the animals continue to live at low pressure. Even 12-month-old animals, and to an increasing extent 18, 24, and 30-month-old animals, need a longer time to accommodate, and the oldest ones may never reach their normal body temperature again.

The mechanism of adaptation has not been explained definitely as yet. Endocrine activities of thyroid, adrenal, and pituitary are not responsible for the quick adaptation, and here again we believe that the disturbance lies in the decreasing capacity of the central nervous system for heat regulation.

Adaptation to low atmospheric or oxygen pressure involved another most interesting problem, namely, retained adaptation (28). If the animals are kept continuously for 2 weeks at the low pressure of 350 mm. Hg, they regain, as mentioned, a normal body temperature. We then take them out of the tank, keep them at 760 mm. Hg pressure, and after two days place them again under low pressure, at which time their body temperature does not drop; they have retained their adaptation to low oxygen pressure. Only young animals, however, retain their adaptation; old animals do not. Again, aging in our rats as tested with the low pressure procedure starts as early as the twelfth month, although 50 per cent of our animals live 24 months and some even over 40 months. At present we have no explanation of the cause and mechanism of retained adaptation, but it might be worth studying this mechanism which changes in such a characteristic way with age.

I should like now to mention adaptation processes which do not show obvious changes with age. We have tested the work hypertrophy of the heart muscle (72). A silver ring is placed

around the aorta to increase resistance, and in this way to produce hypertrophy of the left ventricle. This is an adaptation and we have found it to occur even in very old animals. It is true that especially old animals often do not tolerate this operation, and it may be that we have thus selected biologically young individuals with this test. However, similar observations have been made with other organs where the operative procedure does not lead to the death of the animals.

We also tested compensatory hypertrophy of the kidney after the extirpation of one (73). A month after the extirpation, the remaining kidney had grown to 140 per cent of the original weight. This capacity to compensate by hypertrophy is also maintained in old age. Similarly the compensatory hypertrophy of the adrenal gland was studied one month after extirpation of one gland. The second gland again increased to about 140 per cent. There are differences in compensatory hypertrophy between adult and old animals. It seems that the adult animal needs less hypertrophy to fulfill the increased work, while in young and in aged animals relatively more hypertrophy is necessary.

We do not forget, however, that, with aging, regressive processes are going on in these organs, as is known by pathologists, and a compensatory hypertrophy in old age is therefore the resultant between atrophic and hypertrophic processes. This has still to be analyzed.

May I remind you that it would be of great interest definitely to know whether Lecomte de Noüy's (50) cicatrization test can be used as a measurement of biologic age. This applies also to the test of Carell (50), which shows that the blood plasma of the aged inhibits the growth of fibroblasts in vitro, as well as to Schulz's recent statement (61) that the regeneration of fibrinogen decreases in the aged (this latter observation has not been worked out as a test).

Starting with the idea that changes in the tendons and joints in old age might be an expression of decreased adaptation capacity of the tissues to mechanical forces, we began to study the changes of connective tissue during aging. There are a number of illnesses which seem to be connected with aging, such as rheumatism, arthritis, sclerodermia, senile atrophy of the skin, and even atheromatosis and arteriosclerosis, in which connective tissue and especially elastic and collagen fibers are involved. These became known as collagenous diseases.

If one tests the elasticity of the skin in the simplest way, one sees very clearly a decrease with aging. The increase of pulse wave velocity in man shows also a decrease of elasticity of the arterial wall. It is more difficult to show the same changes in tendons and elastic bands by simple methods.

A few years ago interest was directed mainly to the elastic fibers. In 1949-1950 Banga and Baló (5, 6) published that they had isolated a new enzyme, elastase, which digests elastine. The latter can be prepared from the media of the aorta, a source of elastic fibers. Elastase is different from collagenase, which digests collagen. In their later papers (7-10), elastomucase is mentioned, however, which digests both. It is claimed that elastase can be crystallized, but the available preparations are generally contaminated with collagenase. Only the pancreas produces elastase. Baló, Banga, and Szabo (8) then suggested that elastase has a role in the aging of elastic fibers. An increase of elastase activity during life might lead to a destruction of elastine, especially in the aorta. Since, however, such an increase could be shown neither in the blood plasma nor in the pancreas, it was thought that there is a natural inhibitor of this enzyme during life and that it is this factor which decreases with age. The discussion continues. Saxl (60) recently described elastomucase activity in relation to the so-called clearing factor.

The study of these enzymes offered a good occasion to analyze the structure of collagen and elastine. Collagen is generally obtained from tendons and, after it is digested by collagenase, it becomes digestible with elastase also, like elastine. Banga (9) concluded that collagen is built up of two proteins: procollagen and metacollagen, and that between these two there is a mucoprotein 1 and a mucoprotein 2. There is considerable discussion about the chemistry of collagen and an enormous literature on leather chemistry. I might refer to the excellent book of Gustavson (36) on the chemistry of collagen and to the papers of Randall (58), and also to the important Connective Tissue Symposium organized by CIOMS in London in 1956.

In the meantime the British group of Tunbridge, Hall, and others (15, 37, 38, 39, 40, 41, 63) had published new details on the structure

of collagen and on the close relationship between these two fibrous components of connective tissue. In 1953 they declared that collagen can be transformed into elastine. A transition between these two substances had been suspected by Unna (66) 60 years ago by histologic methods. On the basis of differential staining, he distinguished between collagen, collacin, elacin, and elastine. The changes in aging skin especially are examples of transformation of collagen to elastine-like fibers.

A number of chemical analyses performed by Tunbridge's group also showed that there is a near relationship between collagen and elastine, except that collagen is rich in hydroxyproline whereas elastine contains almost none. The present opinion is that collagen contains a sequence of specific amino acids of which one-third is proline or hydroxyproline (33).

Gustavson (36) has supposed that the stability of collagen is bound up directly with the hydroxyproline content of the molecule. However, Hall's new experiments (39) have shown that, in old age, changes occur also with other amino acid components. He gives further evidence in support of the hypothesis that elastine-like fibers can be produced by the degradation of collagen. However, the breakdown with collagenase produces different fractions to the breakdown with phthalate buffer. We are certainly not dealing with a product which is chemically completely identical with elastine.

While these studies were going on, the Basel group has been studying changes of elasticity of skin and tendons with age since 1951. We found (66, 67) that the single tendon fiber from a rat's tail, which is a pure collagen fiber, is an excellent object for research. Collagen fibrils show, as is well known, a beautiful periodic structure by electronmicroscopic examination. We showed that all tendon fibers present a helical structure even under low microscopic magnification (although only with special side-illumination). Studying the thermic contraction in Ringer's solution, we found that first the helical structure is destroyed; then the fiber contracts, becomes transparent and completely elastic. Since it was known that heat and certain substances like weak acids (acetic acid) liberate mucoprotein from collagen fibers, we suppose that the mucoprotein is localized along this helix on the fiber. The helix inhibits the contraction of the second part of the fiber. If the helix is dissolved, the fiber becomes elastic; it is then transformed, as previously mentioned, to an elastine-like substance. Since this name implies the existence of a chemical entity, we propose using the word "elastoid" instead.

There are differences in the thermic contraction of young and old fibers. It was found that the thermic contraction of young fibers can be inhibited with small weights while those of old animals are inhibited only with much larger ones. There are several other differences too. The smaller the weight, the lower is the activation temperature needed to make the fiber contract.

When the contraction has been produced, a second process starts, namely, an elongation of the fiber. Young animals' tendons are elongated by small weights; old animal fibers need much more weight. Finally, after thermic contraction, young animal fibers break with smaller weights than old animal fibers.

All this leads to the hypothesis that with aging cross-linkages are formed between the filamentous protein molecules which form the elastoid. The measurement of the weight which inhibits thermic contraction has given us a simple method of measuring the biologic age of a certain tendon fiber.

There is a possibility that aging of connective tissue leads to a reaction similar to thermic contraction. Such a theory, however, must also explain the fact that larger weights can be lifted at thermic contraction in an old than in a young tendon.

Further studies of this reaction (69) have shown that weak acids (such as acetic acid) give a slow contraction even at room temperature and at higher temperatures diminish the activation temperature for contraction. Since acids break hydrogen bonds, this is quite plausible.

There are, however, also other substances which influence this reaction, such as urea and urethane. They very distinctly decrease the activation temperature and also increase elasticity. They are well known for their capacity to break up cross-linkages.

A completely contrary effect is seen with formaldehyde and α-quinone; they enormously increase the weight which can inhibit thermic contraction. In young animals, this may be increased from 1 to 30 Gm., in old animals from 10 to 40 Gm. The elasticity is also decreased, but not for large weights, which can completely

elongate these fibers again. These substances are known as tanning substances from their use in the leather industry. For us they have interest because the changes are similar to those found in aging, while acids and urethane change the behavior in the direction of young tissue.

Banga (9) and her group have studied a chemical contraction with 40% potassium iodide. This also dissolves the helix and thus leads to a contraction, even at room temperature. The fiber then also becomes extensible. Banga (10) has now confirmed that old animals' fibers break with larger weights, and larger weights are needed for extension to the original length. All this seems to be quite parallel to our findings with thermic contractions. Lately (10) she studied the action of several organic acids; the tendon fibers were treated with these acids, then dried and again tested with potassium iodide. The contraction time was decreased and the elongation increased. It seems that all this can be explained in the same way as with thermic contraction.

The best known example of aging of connective tissue is the *atrophic changes of the skin* in old age, where, according to Tunbridge (63), collagen fibers are transformed into elastin-like fibers. It is possible that this process is the same as in thermic contraction. The result is that while microscopic collagen fibers disappear and elastine-like fibers are somewhat increased, the elasticity of the tissue is much diminished. I think this is quite understandable. Collagen fibers form the architecture of the tissue; if they are destroyed, the elastic fibers contract and there is no practical use for their forces. Thus actually the tissue becomes less elastic.

There seems to be some possibility that a similar process goes on in the arterial wall. Up to now consideration has chiefly been given to the degenerative changes of the elastic fibers. If, however, the architecture of collagen fibers is destroyed in the same way as in the skin, the result will be the same as in the skin: the elasticity of the tissue decreases. It is thus possible that the age changes in the arterial wall affect not only elastic but also collagen fibers.

This theory does as yet not fit in with the findings in the tendons. Here, on the contrary, we see increased cross-linkaging with aging. Whether these phenomena can be connected with each other is at present unknown. It may well be that the primary age changes are in the ground substance of the connective tissue, where mucoproteins are produced in diminished quantities during aging. Since their role is the stabilizing of the collagen fiber, this would also lead to a decrease of stability. With regard to the aging of several different connective tissues, it seems possible that primarily a decreased action of tissue cells, fibroblasts, and consecutively a diminished production of mucoprotein is the main change. It is remarkable that research on arteriosclerosis is also pointing in the direction of metabolic changes of mucoproteins in the arterial wall and in blood plasma. The work of Greppi and his associates (34, 35) must be mentioned. It may be that one day aging of connective tissue can be related to changes in mucoprotein metabolism (1, 2, 3, 59).

Finally, let us turn to the problem of calcium metabolism, about which it is well known that changes occur with aging. There are facts which indicate that these are also the result of alterations in the connective tissue and especially in the collagen fibers. Actually it has been found (30, 70) that if $Ca^{45}$ is injected into a rat and the radioactivity of the organs tested 48 hours later with a Geiger counter, the calcium uptake of several organs is higher in old than in young animals. The tendons, the lungs, and especially the aorta, show this difference; that is to say, tissues which are rich in collagen and elastine. During thermic contraction, when mucoprotein dissolves, the affinity to calcium increases. We studied this recently (71) with $Ca^{45}$ and showed that thermic contraction, and especially the transparent stage of the isolated tendon fiber, increased the calcium-binding capacity from 100 to 221 or 278%. If aging is a similar process, this might explain why aged animals' tendons bind more calcium than young ones.

Probably the study of connective tissue in aging has produced most understanding of basic changes during aging. These changes are in the protein molecule. Functional differences between young and old are secondary to these chemical changes. It will be the work of the future to study what these changes of the structure of the protein molecule are. May it be that increased cross-linkages are characteristic changes of aging? That might explain the decreased adaptation capacity of the collagen fiber, and one might be allowed—as has been done—to make the hypothesis that similar

cross-linking might also be the cause of a decreased adaptation capacity of other tissues.

Thus I see the most promising future for the understanding of the process of aging in a detailed study of protein chemistry.

*Some Current Experimental Gerontologic Work in Different European Countries:*

The foregoing descriptions of current work were necessarily influenced by the present author's own special interests. The more difficult task will now be attempted of giving some data on the state of experimental gerontologic work in European countries. The countries will be mentioned alphabetically and in spite of important activities in some countries in clinical geriatrics and in social gerontology, information will be limited to examples of experimental work on aging. Apologies are offered for any omissions and it must be emphasized that the selection should not be regarded as an evaluation of merit but merely as a survey of different spheres of interest.

*Austria:* Austria's Gerontological Society held two conferences in 1956, mainly on geriatric problems; the transactions are edited by Doberauer (24) in a volume with 30 lectures on different aspects of aging.

*Belgium:* In Belgium, where the International Association of Gerontology was founded in 1950, Brull has an excellent clinical department at the University of Liège with laboratories for experimental work. Brull (17) recently discussed the changes in chemical constitution which occur with age.

Divry, professor of psychiatry in Liège, is interested in the histologic changes during aging in the central nervous ssytem, especially in amyloidosis (23).

*Finland:* Finland's Gerontological Society publishes a yearbook, *Geron*, with summaries of the papers in English. Karsten, Jalavisto, and Tunkelo are on the Editorial Board. Many of the papers published have psychologic, social, or geriatric aspects. One experimental gerontologic paper is that of Fieandt (25), Personal Tempo and Phenomenal Time at Different Age Levels. A paper from Jalavisto's laboratory deals with the relation of aging to stimulus intensity (45). It is impressive to read about large donations to the research center of the Gerontological Society for experimental research on estrogenic hormones, sensibility of the cornea, and adaptation to environment.

*France:* In France there is the new Centre d' Etudes et de Recherches Gérontologiques in Paris, founded 1950 by Huet, from which you will have direct information from Bourlière. The excellent textbook by Binet and Bourlière (12) is the best proof of the high quality of experimental research on aging in that country. Bourlière will give a review of their work in comparative physiology. His own researches with Joseph and Molinard on aging of the skin (14) should be especially mentioned as an adaptation of physico-chemical methods to studies on aging of a tissue. There is also a Société de Gérontologie de Bordeaux et du Sud-Ouest which was founded in 1956.

*Germany:* In Germany gerontologic research started a long time ago. Abderhalden founded the *Zeitschrift für Altersforschung*, which is now edited by Bürger in Leipzig and which has reached its tenth volume. A large part of its content are papers from his own group. Systematic research in age changes in different organs (eye, cartilage, etc.) has been carried out in a very exact way. Bürger (18) has summarized these studies in his book, *Altern und Krankheit*, published 1957 in the third edition.

Many of the publications in the above mentioned journal are in the field of clinical gerontology; only a few papers deal with experimental work on animals. Of special interest lately are papers on the changes of plasma protein fractions with age in Wistar rats by Uebel (64) and by Nöcker and Bemm (54). Age changes in the chemistry of muscles are published by Lohmann, Wielepp, and Nöcker (51) and changes measured with myometric methods by Bajusz (4). Bürger (18) reviewed the nucleotide and ganglioside content of the human central nervous system in aging. Morphologic changes, studied especially by Wahren (74) from Vogt's laboratory and audiometric work by Fleischer (26) should be mentioned.

*Great Britain:* The British Society for Research on Ageing has produced excellent experimental work. Korenchevsky is the senior experimental gerontologist in this country. Not only has his continuous stimulation in England and other countries led to the formation of various gerontologic societies, but it has produced a large number of publications in different fields of research on aging. Recently, in Whittington Hospital he has worked on autointoxication as connected with aging (48) and

has summarized this work in his lecture at the Symposium on Experimental Gerontology (49).

Comfort's book on the Biology of Senescence (19) contains a large amount of material on the comparative biology of aging.

The important work of Tunbridge, Hall, and their associates (15, 37, 38, 39, 40, 41, 63) on connective tissue has already been referred to. Danielli works on the aging of single cells (20). Olbrich, whose early death is a great loss, worked on water metabolism (55). The Nuffield Foundation has given support to several research units in this country, such as the Experimental Psychological team of Welford in Cambridge, and the Experimental Physiological team of Franklin in St. Bartholemew's Hospital in London, where interesting experiments are being made by Lindop and others.

Special mention should also be made of the activities of the Ciba Foundation in London, which has published three volumes of Colloquia on Aging reporting research on aging from all over the world. The Ciba Foundation is also famous for the Ciba awards which have been given for the last three years for papers on gerontology.

*Holland:* In Holland the Gerontological Society has the support of Mühlbock at the Cancer Research Institute and clinicians such as Groen. Mühlbock works on experimental cancer (53) and his co-worker, Thung, has studied amyloidosis (62).

*Hungary:* Hungary has a very active Gerontological Research group. Banga and Baló and their co-workers (5-10) are well known for their research on collagen and elastic fibers and on elastase. Another group is that of Haranghy (42), who, as a pathologist, works with histologic methods on tissue changes connected with experimental work on conditioned reflexes (43).

It should be mentioned that interest in gerontology in this country was high as long as 20 years ago, especially under the stimulating influence of Professor Alexander Korányi, the internist.

*Italy:* Since 1953, the *Giornale di Gerontologia*, edited by Greppi in Florence and now in its fifth volume, is the official publication of the Gerontological Society. Its contents pertain mainly to geriatrics. A number of conferences have been organized and many articles have been published from papers presented. Attention may be called to the work of Antonini, Mininni, and Salvini (1-3) summarized in 1957 in the Symposium on Arteriosclerosis; and to the work of Salvini, Scardigli, and Guidi (59), Galletti and Abbatti (31) and Greppi (34, 35) on arteriosclerosis, all working in Florence.

Another group is that of Di Macco (21, 22) in Rome, who has published work on changes with age in the reaction to cholinergic stimuli, in several different journals on physiology and pathology and in the Symposium on Experimental Research on Ageing in Basel in 1956.

There is also another journal in Italy concerned with the problems of old age: the *Archivio di Medicina Mutualistica*, published by the Istituto Nazionale per l' Assicurazione contro le Malatie, which reached its fifth volume in 1957. I should like to mention certain articles of it, such as Foà's Illusioni e Possibilità in Temadi Profilassi della Vecchiata (29), Di Macco's Aspetti Biologici e Patologici della Senescenza (22), and Greppi's La Vecchiata come Mallattia e l' Invecchiamento come sua Fase Precoce (34).

Other Italian journals are *Longevità*, *Acta Gerontologica*, *Archiva de Vecchi*, and *Revista de Gerontologia e Geriatria*.

*Roumania.* Research on problems of gerontology goes back to Marinesco, who worked on neurologic problems and to Parhon (57), who worked on endocrinology. The latter is the Director of the Institute of Gerontology and Geriatrics in Bucarest, which was founded in 1944, and since 1951 has had a clinical division for the aged and a research division. Parhon, with Aslan, reported at the 1956 Symposium on Experimental Gerontology (56) on novocain therapy in relation to aging, for which excellent results were claimed.

*Switzerland:* The Gerontological Society of Switzerland, which was founded in 1953, held a Symposium in Basel in 1954 on The Possibility of Experimental Research on Ageing and in 1956 an International Symposium, sponsored by the European section of the Biological and Medical Research Committee of the International Gerontological Association. The transactions of the latter contain 40 papers. The lectures were very heterogenic, but they gave a good picture of the work which is going on in Europe. The intention was to learn who is working in the field of gerontology, and in which directions. Papers given by the different authors have been quoted above.

A small laboratory of Experimental Gerontology has existed since 1956 in the Institute of

Anatomy of the University of Basel, led by the present author, where also a journal for experimental gerontology *(Gerontologia)* is edited.

*Other countries:*

In Denmark Professor Geill (32) has worked with great activity on problems of blood coagulation in the aged.

In Ireland Professor Jessop (46) has studied carbohydrate metabolism in the aged.

The Gerontological Societies of Sweden, Norway, Spain, and Portugal seem as yet to be mainly interested in social and geriatric problems.

REFERENCES


1. Antonini, F. M., and Salvini, L.: Applicazione del Elettroforesi su Carta allo Studio del Metabolismo Proteico e Lipoproteico nell' Aterosclerosi Umani. *Gior. Gerontol., 1:* 207-217, 1953.
2. Antonini, F. M., and Mininni, G.: Studio sui Mucopolisaccaridi Plasmatici e dell' Aorta nel l' Aterosclerosi Sperimentale da Colesterolo. *Arch. Biochim. ital., 17:* 28-32, 1955.
3. Antonini, F. M., and Salvini, L.: Mucopolysaccharides, "Clearing Factor," Age and Arteriosclerosis. *Bull. Acad. Suisse Scs. Med., 13:* 209-228, 1957.
4. Bajusz, E.: Die Beziehungen einiger myometrischer und myographischer Untersuchungsergebnisse zur Gerontologie. *Ztschr. f. Alternsforsch., 10:* 27-39, 1956.
5. Baló, I., and Banga, I.: Elastase and Elastase Inhibitor. *Nature, 164:* 491-498, 1949.
6. Baló, I., and Banga, I.: Elastic Activity. *Biochem. J. 46:* 384-390, 1950.
7. Baló, I., and Banga, I.: Vergleichende Untersuchungen über Elastolyse. *Acta morphol. Hung., 4:* 141-151, 1954.
8. Baló, I., Banga, I., and Szabo, D.: Studies of Elastolysis. *Acta physiol. Hung., 6:* 235-247, 391-400, 1956.
9. Banga, I.: On the Structure of Collagen Fibre. *Acta morphol. Sci. Hung., 4:* 33-40, 1954.
10. Banga, I.: Der Effekt der schwachen organischen Säuren auf die Rattenschwanz-Kollagenfasern von jungen und alten Tieren. *Gerontologia, 1:* 325-346, 1957.
11. Bernstein, F.: Law of Physiologic Ageing as Derived from Long Range Data on Refraction of the Human Eye. *Arch. Ophth., 34:* 378-388, 1945.
12. Binet, L., and Bourlière, F.: *Précis de Gérontologie,* Masson, Paris, 1955.
13. Bogomoletz, V.: *The Secret of Keeping Young.* Arco Publications Ltd., London, 1954.
14. Bourlière, F., Joseph, N. R., and Molinard, R.: Ageing of Skin. 2. Adaptive Responses in Rat Dermis in Relation to Age and Growth. *Gerontologia, 1:* 18-40, 163-173, 1957.
15. Burton, D., Hall, D. A., Keech, M. K., Reed, R., Saxl, H., Tunbridge, R. E., and Wood, M. J.: Apparent Transformation of Collagen Fibrils into 'Elastin.' *Nature, 176:* 966-969, 1955.
16. Brückner, R., Gsell, O., Hügin, F., Batschelet, E., and Verzár, F.: Fortlaufende Erfassung des Alternsprozesses. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
17. Brull, L., and Keil, C.: Chemical Constitution of the Mouse According to Age. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
18. Bürger, M.: *Altern und Krankheit.* 3rd ed. Thieme, Leipzig, 1957.
19. Comfort, A.: *The Biology of Senescence.* Rinehart Co., New York, 1956.
20. Danielli, J. F.: On the Ageing of Cells in Tissues. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
21. Di Macco, G.: La Toxicose Acétycholinique et Ganglioplégique dans l' Age Avancé. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
22. Di Macco, G.: Aspetti Biologici e Patologici della Senescenza. *Arch. Medic. Mutualistica, 5:* 61-126, 1957.
23. Divry, P.: De la Notion d' Amyloidose Cérébrale dans les Processus Séniles. In *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
24. Doberauer, W.: *Alter und Krankheit.* Gesellschaft zur Förderung wissenschaftlicher Forschung, Vienna, 1957.
25. Fieandt, K.: Personal Tempo and Phenomenal Time at Different Age Levels. *Geron., 8:* 85-101, 1956.
26. Fleischer, K.: Audiometrische Untersuchungen über die Altersschwerhörigkeit. *Ztschr. f. Alternsforsch., 10:* 70-83, 1956.
27. Flückiger, E., and Verzár, F.: Senkung und Restitution der Körpertemperatur bei niedrigem atmosphärischem Druck. *Helvet. physiol. et pharmacol. acta, 10:* 349-359, 1952.
28. Flückiger, E., and Verzár, F.: Ueberdauern der Adaptation an niedrigem atmosphärischem Druck. *Helvet. physiol. et pharmacol. acta, 11:* 67-87, 1953.
29. Foà, C.: Illusioni e Possibilità in Temadi Profilassi della Vecchiata. *Arch. Med. Mutualistica, 5:* 31-57, 1957.
30. Freydberg-Lucas, V., and Verzár, F.: Der Calciumstoffwechsel verschiedener Organe bei jungen und alten Tieren. *Gerontologia, 1:* 196-212, 1957.
31. Galetti, F., and Abbatti, A.: Eparina e Arteriosclerosi. *Gior. Gerontol., 5:* 679-683, 1957.
32. Geill, T.: Studies on Blood Coagulation in Old Age. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
33. Grassmann, W.: Aminoacid Sequences of Collagen. *Symposium on Connective Tissue.* Blackwell, London, 1957, 308-321.
34. Greppi, E.: La Vecchiata come Malattia e l' Invecchiamento come sua Fase Precoce. *Arch. Medic. Mutualistica, 5:* 129-162, 1957.
35. Greppi, E.: L' Aterosclerosi: Patologia Metabolico Vascolare dell' Uomo, nel Quadro Biologico e Clinico dell' Invecchiamento. *Gior. Gerontol., 5:* 649-664, 1957.

36. Gustavson, K. H.: *The Chemistry and Reactivity of Collagen.* Academic Press, New York, 1956.
37. Hall, D. A.: Elastin from Human Tissue and from Ox Ligament. *Nature, 168:* 513, 1951.
38. Hall, D. A.: Thermal Contraction of Collagen and Its Dissolution with Elastase. *Nature, 172:* 1099-1100, 1953.
39. Hall, D. A.: Collagen and Elastin: The Effect of Age on Their Relationship. *Gerontologia, 1:* 347-363, 1957.
40. Hall, D. A., Reed, R., and Tunbridge, R. E.: Structure of Elastic Tissue. *Nature, 170:* 264-266, 1952.
41. Hall, D. A., Reed, R., and Tunbridge, R. E.: Electron Microscope Studies of Elastic Tissue. *Exper. Cell. Res., 8:* 35-48, 1955.
42. Haranghy, L.: Reaktionsformen der Milz und des Knochenmarks bei Säuglingen mit mehreren aufeinanderfolgenden Schädigungen, *Acta Med. Hung., 6:* 117-134, 1954.
43. Haranghy, L., Rácz, P., Hársfalvy, E., and Király, F.: Sclerosis of the Spleen in Old Age and Concomitant Changes of the Bone Marrow, In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
44. Hügin, F., and Verzár, F.: Versagen der Wärmeregulation bei Kälte als Alterserscheinung. In: *Experimentelle Alternsforschung,* F. Verzár ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
45. Jalavisto, E., Orma, E., and Tawast, M.: Ageing and Relation Between Stimulus Intensity and Duration in Corneal Sensibility. *Acta physiol. scandinav. 23:* 224-334, 1951.
46. Jessop, W. J. E.: The Effect of Ageing on Carbohydrate Metabolism. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
47. Korenchevsky, V., Paris, S. K., and Benjamin, B.: Treatment of Senescence in Male Rats with Sex and Thyroid Hormones and Desoxycorticosterone Acetate. *J. Gerontol., 8:* 415-434, 1953.
48. Korenchevsky, V.: Treatment of Senescent Male Rats with Cortisone Acetate Alone or Together with Sex and Thyroid Hormones. *J. Gerontol., 11:* 261-267, 1956.
49. Korenchevsky, V.: Problem of Autointoxication in Gerontology. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
50. Lecomte de Noüy, P.: Cicatrization of Wounds. *J. Exper. Med., 24:* 451-460, 461-470, 1916.
51. Lohmann, D., Wielepp, G., and Nöcker, J.: Age Changes in Muscles. *Ztschr. f. Alternsforsch., 10:* 233-238, 1956.
52. Michel, D., and Hartleb, O.: Kritische Betrachtungen zur Brauchbarkeit der Pulswellengeschwindigkeit als Altersindex. *Ztschr. f. Alternsforsch., 10:* 296-306, 1957.
53. Mühlbock, O.: Advanced Parental Age and Spontaneous Cancer in Mice. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
54. Nöcker, J., and Bemm, H.: Einwirkung des Alters auf die Serumproteine. *Ztschr. f. Alternsforsch., 9:* 222-232, 1955, 328-339, 1956.
55. Olbrich, O., Ferguson, M. H., Robson, J. S., and Stewart, C. P.: Renal Function in Aged Subjects. *Edinburgh M. J., 57:* 117-127, 1950.
56. Parhon, C. J., and Aslan, A.: Discussion. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
57. Parhon, C. I., and Milcu, S. M.: *The Rumanian Endocrinological Institute.* Foreign Languages Publishing House, Bucharest, 1957.
58. Randall, I. T.: *Nature and Structure of Collagen.* Butterworths, London, 1953.
59. Salvini, L., Scardigli, G., and Guidi, G.: Il Carico Lipidico Prolungato in Soggetti Normali ed in Aterosclerotici. *Gior. Gerontol., 5:* 48-66, 1957.
60. Saxl, H.: The Physiological Significance of the Reaction Between Elastin and Elastomucase in Relation to the Production of "Clearing Factor." *Gerontologia, 1:* 142-163, 1957.
61. Schulz, F. H.: Fibrinogen Regeneration During Ageing. *Ztschr. f. Alternsforsch. 5:* 192-203, 1951, *10:* 318-324, 1957.
62. Thung, P. J.: Senile Amyloidosis in Mice. *Gerontologia, 1:* 259-269, 1957.
63. Tunbridge, R. E., Tattersall, R. N., Hall, D. A., Astbury, W. T., and Reed, R.: Apparent Transformation of Collagen Fibrils into "Elastin." *Clinical Sci., 11:* 315-325, 1952.
64. Uebel, H.: Über alternsabhängige Verschiebungen der Serumeiweisskörper bei Wistarratten. *Ztschr. f. Alternsforsch., 10:* 149-152, 1956.
65. Unna, P. G.: Elastin und Elacin. *Monatsh. prakt. Dermat., 19:* 339-402, 1894.
66. Verzár, F.: Das Altern des Kollagens. *Helvet. physiol. et pharmacol. acta, 14:* 207-227, 1956, *Connective Tissue Symposium,* R. E. Tunbridge, ed., Oxford, 1956.
67. Verzár, F.: The Ageing of Connective Tissue. *Gerontologia, 1:* 363-378, 1957.
68. Verzár, F.: Studies on Adaptation as a Method of Gerontological Research. *Ciba Foundation Colloquia on Ageing,* 3: 60-68, 1957.
69. Verzár, F.: Influence of Different Chemical Substances on Collagen Fibers of Young and Old Animals. *Gerontologia, 2:* in press, 1958.
70. Verzár, F., and Freydberg-Lucas, V.: $Ca^{45}$ Turnover in Young and Old Animals. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel and Stuttgart, 1956.
71. Verzár, F., and Freydberg-Lucas, V.: $Ca^{45}$ Uptake and Turnover of Tendon Fibers Influenced by Thermic-contraction and Age. *Gerontologia, 2:* 10-20, 1958.
72. Verzár, F., and Hügin, F.: Untersuchungen über die Arbeitshypertrophie des Herzens bei jungen und alten Ratten. *Arch. ges. Physiol., 262:* 181-191, 1956.
73. Verzár, F.: and Hügin, F.: Einfluss des Alters auf die Entwicklung der Arbeitshypertrophie von Organen. *Anat. Acta, 30:* 918-927, 1957.
74. Wahren, W.: Neurohistologischer Beitrag zu Fragen des Alterns. *Ztschr. f. Alternsforsch., 10:* 343-356, 1957.
75. Wertheimer, E., and Bentor, V.: Adaptation of Young and Old Rats to Short Cold Exposure. *Gerontologia, 1:* 306-312, 1957.

# THE COMPARATIVE BIOLOGY OF AGING
## Some Selected Problems

F. BOURLIÈRE, M.D.

*(Centre de Gérontologie Claude Bernard and Laboratoire de Physiologie, Faculté de Médecine, Paris)*

Age changes in man are now fairly well documented as a result of the many studies made during the last two decades by numerous biochemists, physiologists, pathologists, and psychologists. Much remains to be done, but the general pattern of the morphologic and functional changes occurring after maturity begins to appear clearly. The mechanism of aging—its biochemical and physiologic bases—nevertheless remains mysterious and one may wonder whether the study of a single species is the best way to understand the nature of such a widespread phenomenon.

It is obviously impossible in so short a paper to review all the various investigations which have been made during the last 15 years on the comparative biology of senescence. Comfort (17) has recently devoted a whole book to the subject, emphasizing in a very fine way the ecologic side of the problem. I shall therefore limit myself to some selected points which raise intriguing physiologic questions and require more experimental work.

### *Senescence, a Universal Phenomenon in Living Beings*

It is still often maintained that "natural death" does not occur in Protozoans, these organisms being potentially immortal. This assumption is based on Weissmann's (70) classic remark that an individual amoeba, for instance, does not die, properly speaking, since it divides into two parts possessing the same constitution. Each of these daughters organisms will divide itself into two other amoebas, and so on indefinitely—without any dead bodies. Recent research does not support the universality of such a "clonal immortality." It seems now that most, if not all, clones ultimately die if they do not undergo some form of sexual reproduction or nuclear reorganization. Even in the famous Woodruff (71, 72, 73) experiments on *Paramecium aurelia,* whose cultures were maintained in a healthy state from 1907 to 1943, endomixis did occur periodically. If such a process does not take place, as in the strain of the same species selected by Sonneborn (63), the colony invariably dies after 4 or 5 months. Moreover the same protistologist has recently established that in various species of *Paramecium* which are morphologically almost identical, very different lengths of clonal life can be found under conditions simulating those in nature. Significantly the short-lived populations are those formed by inbreeders, whereas the long-lived ones have special mechanisms that prevent inbreeding. Working on very different kinds of unicellular organisms, the Ascomycete *Podospora anserina,* Rizet (49) similarly found that it was impossible to obtain a continuous and unlimited vegetative reproduction.

All these experiments emphasize the importance of sexual reproduction and nuclear reorganization to prevent aging of protozoan populations, but they do not bring much light on the age-changes which take place within the individual organisms themselves. After all, the likeness between clonal senescence and the aging of an individual Metazoan is merely a superficial analogy; an integrated pluri-cellular organism being much more than a population of single-celled individuals.

More significant is the fact that some individual Protozoa at least undergo age-changes which recall in some way those observed in pluri-cellular organisms. The fascinating observations made recently by Rudzinska (52-57) on *Tokophrya infusionum* have established that in older (10-12 days old) individuals definite nuclear and cytoplasmic changes do occur. Some chromatine bodies of the enlarged macronucleus were found to possess a highly organized structure, whereas in the cytoplasm mitochondria are larger and less numerous than in the young (3-4 days old) *Tokophrya.* The endoplasmic reticulum is well represented in the juvenile organism and very poorly in the older one. Large areas in the cytoplasm of the old protozoan are filled with waste products. When overfed, *Tokophrya* changes to a giant individual, exceeding, on the average,

120 times the previous size of its body, and its life span is greatly reduced (6.87 days as compared with 13.2 days for individuals kept on a meager diet). Now overfeeding produces in the macronucleus the same "honeycomb" structure which has been found to occur in "normal" senile *Tokophrya*. The importance of such findings cannot be underestimated as they show, for the first time, definite age-changes taking place in individual single-celled organisms. A physiologic study of the aging processes of these suctorians would, therefore, be of the utmost importance.

There are some other kinds of "lower" animals which are said to escape death in much the same way *Paramecium* does. In hydroids and some flatworms, life seems to continue indefinitely, through continued branching, budding, or division. Yet it is only the newly formed buds or branches that continue to live in this way; the parts that are early differentiated commonly become senile and finally die. Abeloos (1) has studied, for instance, the "senile phase" of the life-cycle in the Planarian *Polycelis gonocephala*. As soon as this flatworm has ceased growing and reaches its maximum size, it starts to "degrow" slowly, to lay less "cocoons" and to become less active. During the same time, various degenerative changes take place, such as the appearance of supernumerary eyes and an abnormal pigmentation. It is significant to note that all these changes occur more rapidly in planarians raised at 20-23 C. than in those maintained at 10-15 C.

Senile changes do exist also in hydroids. Gross (29) was unable to keep his *Pelmatohydra oligactis* alive for more than 349 days. As soon as they had reached their fourth month of life, his animals became smaller, even in the presence of abundant food. Furthermore their budding became irregular and hypertrophic.

That binary fission does not necessarily imply an equal "rejuvenescence" of the two daughter organisms is well shown, on the other hand, by the results of the classic experiments of Sonneborn (61) on *Stenostomum incaudatum*. The lines of the anterior portions of that flatworm can live only a limited time ($35.0 \pm 1.1$ days on the average), while the lines of the posterior portions lived as long as they were kept under observation (3 years). As Comfort (17) has rightly pointed out, senescence probably occurs in every group where the power of regeneration or fissile reproduction is less than total, or where body cells are not continuously and "indeterminately" replaced.

Another very different kind of organism is also commonly supposed not to age—their death being only due to accident or disease. These are the perennial plants, such as the dicotyledonous or coniferous trees. As a matter of fact some of these plants have the longest life span ever recorded for living beings. Specimens of the giant redwood trees of California *(Sequoia gigantea)* are estimated to have lived for some 3,000 years, attaining a height of over 300 feet and a diameter, at breast height, of 24 feet. In the same way, some swamp cypress *(Taxodium mexicanum)* are estimated to be 4,000 years old (Molisch, 40). Such trees consist essentially of a living layer surrounding a double cone of dead wood and surrounded in turn by a skin of dead bark (Heath, 31). The aerial half of the double cone bears at the top a succession of more or less ephemeral living organs, the leaves (and from time to time the flowers). The subterranean half bears at the bottom a succession of even more ephemeral living organs, the root hairs. All the working parts of the tree are thus continually renewed. The growth in length of each half of the double cone results from cell division in an embryonic zone, the terminal meristem, whereas the growth in girth arises mainly from new cells formed by a continuous merismatic layer, the cambium. All the cells of such a tree, living at any given time, will a few years later have been added to the dead wood or bark, or have become detached with the dead leaves or flowers, or with the fruits. Thus, the tree will have become an entirely new individual, in the sense that a plant from a cutting is a new individual.

It would therefore seem that the meristems should be ageless as they are renewed continually. Nevertheless this is not the case, as they are found to show systematic changes with time (Heath, 31). Information concerning the physiologic changes taking place with age in plant meristems is still scanty (Robbins, 50), but active experimental research in that field will certainly yield very important results. Of particular interest are the recent results obtained with annuals and some perennials, which show that senescence and death are associated in part with the production of flowers,

fruits, and seeds. For these plants the prevention of flowering may extend their length of life considerably. Even more interesting are the experiments made on some plants which go through more or less defined juvenile and adult stages, such as those made on the English ivy *(Hedera helix)*, which have shown that treatment of the adult cuttings with cold or X-rays caused rejuvenation (Frank and Renner, 27).

It therefore seems more and more likely that aging processes are universal among living beings and that few, if any, organisms are able to escape the effects of the passage of time. Thus we come to the second question to be discussed in this report:

### *Various Patterns of Aging*

Even if we limit ourselves to the Metazoa it becomes readily apparent that age changes cannot be reduced to a single general pattern.

Some animals have a determinate growth-period, at the end of which their body reaches a definite form and size, and then ceases growing. This period of growth is commonly followed by a period of maturity, then of senility followed by death. Thus the whole life-cycle of the animal can be divided into three successive phases (growth, maturity, and senility) whose duration is approximately the same for all the individuals belonging to the same species. The average duration of life of a population varies, to be sure, according to the ecologic conditions but the maximum (potential) life span which can be attained by the members of the species living in the most favorable environments is always approximately the same.

Such a determinate aging pattern is characteristic of the warm-blooded vertebrates (mammals and birds), but is also to be found among some invertebrates like insects and rotifers. As Comfort (17) rightly pointed out, most holometabolous imagines give every evidence of having a sharp specific age, although the nature of the processes which limit imaginal life seems to vary widely. Rotifers, on the other hand, are one of the best examples of strictly determinate development. After a brief period of cell division, lasting but a few hours, the individual enters a period of growth which takes place by increase in cell size, the nuclear number being fixed. Next follows a brief period of maturity, during which reproduction occurs, followed by a period of senescence ending in death. The life span naturally varies in different species, but each of these tends to exhibit a very sharp specific age.

It must nevertheless not be inferred from this subdivision of the life-cycle into three successive phases that age changes start only during the last part of the life-cycle. On the contrary many are noticeable much earlier in life and there are numerous instances, in man and laboratory mammals, of physiologic functions and mental abilities whose decline is perceptible from the very beginning of the maturity period. Even in the rotifers the senescent phase is not limited to the post-reproductive phase; in the majority of cases it already occurs while egg-laying is still in process—although at a lower rate.

Higher vertebrates and invertebrates with determinate growth have another characteristic in common. They are usually unable to regenerate lost parts of their organism and, furthermore, their power of somatic cell renewal is usually limited to very few tissues.

The situation is quite different in those animals, like most cold-blooded vertebrates and some invertebrates, whose form and size are not definitely fixed and whose growth is indeterminate. Such species usually grow as long as they live and there is apparently no senile involution among them. If we take, for instance, the annual production of eggs as a criterion of age-changes, we find that in most species fertility does not generally lessen with age, the bigger and older the female the greater being its capacity to produce eggs. This pattern of reproductive aging is therefore the opposite of that found in mammals and birds, whose fertility is maximal very early in life and decreases regularly afterwards.

There are also some invertebrates which are supposed to have an indeterminate growth. Such seems to be the case of some pelecypod mollusks, whose age can be estimated by growth rings. Among Fisher-Piette's (24) limpets, for instance, growth continued in the oldest recorded specimens. We have unfortunately no idea of the age-changes in fertility among these animals. Sea-anemones are another good example of prolonged and indeterminate growth (Comfort, 17), but we do not know whether gametogenesis continues likewise throughout life in these animals.

All these species with prolonged growth, both vertebrates and invertebrates, have at the same

time a rather indeterminate life span, i.e., their maximum (potential) longevity varies considerably according to the prevailing ecologic conditions. The same species of fish living in two different lakes can reach at the utmost 6 years in one case and 12 in the other. Similarly *Patella vulgata* dies when 3 years old in one environment but can live 16 years in another place (Fisher-Piette, 24). It is equally worth noticing here that many animals which have both indeterminate growth and life span retain also some power of regeneration.

It would nevertheless be misleading to draw too sharp a line of demarcation between determinate and indeterminate growth, life span, and aging patterns. Even in the same class we can find mixed or intermediate conditions. In fishes, for instances, many species stop growing after reaching some maximum size and never grow again, even if they live for an appreciable time after growth ceases (Gerking, 20). Even in the same species one can find striking sexual differences; the female guppy continues to grow throughout life, although exhibiting the characteristic decline in rate, whereas the male ceases growing relatively early and then maintains a constant size until death. In species which have a prolonged growth the progressive increase in fertility of the females is, on the other hand, by no means universal. Some fishes lose their reproductive capacity gradually and become sterile after a definite number of years. Gerking (28) mentions that brook trout in hatcheries do so gradually and have to be discarded after a few years. In goldfish, according to Comfort (17) fertility reaches a maximum under aquarium conditions in the third year of life and then declines. In the female North Sea haddock, whose average egg production per year increases from 31,000 eggs in the second year of life to 278,000 eggs in the sixth and 3,295,000 in the eleventh, Raitt (45) has found a slight decline in egg production in the oldest individuals. The small short-lived and viviparous *Gambusia affinis* has a definite period of sterile senility following reproduction, although females continue to grow until they die (Krumholz, 34). Moreover Rasquin and Hafter (46) have found definite degenerative changes in the male gonads of old *Astyanax americanus*. Among reptiles a slight decrease of egg-production in the oldest female rattlesnakes has also been reported (Bourlière, 9). Such observations would lead us to think that the determinate and indeterminate aging patterns are, after all, probably not so basically different as generally supposed. The difference may be more a matter of tempo than a difference of mode, but more observations and experiments are needed to settle that question.

*Aging and Environmental Temperature*

Although the comparative study of aging processes is still in its infancy, there is already some indication that various ecologic factors are able to exert a definite influence upon the rate of senescence. The most important—or at least the best documented in our present state of knowledge—is environmental temperature whose influence has been demonstrated both in invertebrates and in cold-blooded vertebrates.

Some 20 years ago, Mac Arthur and Baillie (37) studied parthenogenetically produced males and females of one pure line of *Daphnia magna* which were kept at various temperatures (8, 10, 18, and 28 C.), the other factors remaining constant. In these conditions the length of life of these Cladocerans varied considerably. When the mean life span averaged 25.586 $\pm$ 0.28 days at 29 C., it increased to 41.675 $\pm$ 0.35 days at 18 C., to 87.8 $\pm$ 1.98 days at 10 C., and to 108.18 $\pm$ 2.43 days at 8 C. The temperature coefficient for longevity was 2.12, which closely approximates that for most chemical reactions, but the $Q_{10}$ values were higher (2.59) in the lower ranges and lower (1.64) in the highest ranges of temperature. These results are confirmed by the findings of Terao and Tanaka (65) on another Cladoceran *Moina macrocopa*. The maximum duration of life of this species takes place at about 15 C. (14.36 $\pm$ 0.38 days), and gradually decreases at higher temperatures (9.28 $\pm$ 0.18 days at 21 C.; 6.51 $\pm$ 1.67 days at 27 C.; 4.77 $\pm$ 0.06 days at 33 C.). Below 15 C., however, the life span does not increase any more.

Alpatov and Pearl (3), on the other hand, have investigated the action of temperature upon the duration of life of *Drosophila melanogaster*. Their results show that the effect of the temperature during embryonic, larval, and pupal development upon the duration of imaginal life is as striking in insects as in crustaceans. A high temperature (28 C.) during development shortens the duration of the subsequent imaginal life at all temperatures and in both sexes, with but one exception. For in-

LIBRARY
BOSTON UNIVERSITY
SCHOOL OF MEDICINE

stance, females reared at 28 C. had a mean duration of life of 28.52 ± 0.34 days, while the ones reared at 18 C. lived 70.1 ± 0.98 days. The effect of temperature during imaginal life upon the duration of life of the imago itself is quite as striking; as the environmental temperature is higher flies live, on the average, a shorter time. This last finding confirms the results of earlier experiments by Loeb and Northrop (36). The longevity of *Musca domestica* likewise decreases as the environmental temperature rises (Feldman-Muhson, 23).

The aging of Planarians seems also accelerated by higher temperatures, as shown by Abeloos' (1) experiments. Besides these experiments numerous field observations seem to confirm this point of view. The duration of the whole life cycle in many tropical insects seems to be much shorter than that of related forms living in more northern environments. To quote but one sample, some Pierids of South Eastern Asia are able to reach their imaginal stage in only 17 days, the egg stage lasting two days, the caterpillar stage no more than 8 days and the pupal stage 7 days (Fountaine, 26). On the contrary there is evidence that the larvae of some arctic butterflies do not transform into pupa before their third summer (Klots, 32).

This accelerating effect of environmental temperature on the aging processes is not limited to invertebrates, but is also encountered in fishes, amphibians, and reptiles. Fishes present many instances to strengthen this point. The maximum length of life of the arctic population of the North-American Grayling *(Thymallus signifer)* is about two times that of the southern one—12 instead of 6 years (Brown 13; Miller, 38). The lake trout *(Salvelinus namycush)* does not live for more than 20 years in Lake Michigan, whereas it can reach 37 years in the Great Bear Lake in Northern Canada (Van Oosten, 67; Miller and Kennedy 39). The large-mouth bass *(Micropterus salmoides)* shows the same relationship between maximum age and latitude; in Louisiana it does not exceed 11 years but reaches 15 years in Wisconsin (Bennett, 7; Stroud 64).

The duration of the larval period (thence quite probably of the whole life-cycle) of some widely distributed species of amphibians likewise varies greatly with latitude. In North America, for instance, the bullfrog *(Rana catesbeiana)* undergoes metamorphosis at the end of its first winter in Louisiana, while in the extreme northern part of its range (Nova Scotia) this species may spend three winters as a tadpole (Oliver, 42).

Among lizards striking latitudinal differences in longevity are also known. In Florida, for instance, most of the southern Fence lizards *(Sceloporus undulatus undulatus)* were found to live less than one year and none lived in their natural environment for two years. This warm climate permits the lizards to be active every month of the year with only brief irregular periods of inactivity resulting from low temperatures. In these conditions they grow throughout their short life span. On the other hand, the northern race of the same species *(Sceloporus undulatus hyacinthinus)* usually lives, in Maryland, for more than 4 years—probably reaching a maximum age of 8 years. Under this colder climate the lizard is active for only 7 months of the year and its growth seems to stop after about the fifth or sixth year (Oliver, 42).

### *Aging and Body Temperature*

If the influence of the environmental temperature on the rate of aging of poikilothermic animals has been suspected for a number of years, the possible influence of body temperature on the processes of senescence in homeothermic vertebrates has been evidenced but recently (Bourlière, 10).

The idea originated from the fact that mammals of similar size have often strikingly different life spans, the ones enjoying the greatest maximum longevity being precisely those having the poorest internal temperature control. When one compares, for instance, the potential life span of rodents and bats of the same size, one cannot help noting the fact that rats and mice cannot live longer than 4 or 5 years, whereas the small insectivorous bats can live 4 times as long (Bourlière, 10). To quote but a few instances: the life span of the guinea pig *(Cavia porcellus)* does not exceed 8 years, that of the garden dormouse *(Eliomys quercinus)* and the long-tailed deermouse *(Peromyscus maniculatus)* 5.5 years, that of the black rat *(Rattus rattus)* 4 years, that of the house mouse *(Mus musculus)* 3 years, and of the harvest mouse *(Micromys minutus)* 2.5 years.

On the other hand the maximum life span of Chiroptera is much longer, as shown in table 1, which summarizes most of the available data.

Contrary to what happens in most of the other groups of animals the potential longevity under wild conditions seems as long as that in captivity and the species living in temperate climates behave in much the same way as those adapted to tropic environments. The difference between rodents and bats is even more striking when one compares species of similar size: the harvest mouse (average weight, 5.5 Gm.), and the *Myotis mystacinus* (average weight, 5 Gm.) for instance.

The mean length of life of wild populations of rodents and bats living in their normal ecologic environment shows the same sharp differences. The brown rats *(Rattus norvegicus)* studied by Davis (18) on a farm near Baltimore had a very short expectation of life at birth, no more than 5 per cent lived for one year. The 12 species or subspecies of tropical rats similarly studied by the marking-recapture method by Harrison (30) in Malaya, were equally short-lived. Their mean length of life varied from 3 to 9 months, whereas the maximum longevity recorded in the same environment ranged from 4 to 26 months. Bats, on the other had, have a much longer mean length of life. Sluiter, Van Heerdt and Bezem (60) were able to follow wild populations of *Myotis mystacinus* for 13 years in Holland and to calculate, through marking-recapture method, the survival rate and the longevity of this species. Their results show that the annual mortality rate is constant at a level of about 0.20 during adult life, that the life span should reach 20 years and that the expectation of life at birth is of 4.4 years.

Thus one can no longer doubt that rodents and bats have very different aging patterns, but is there any physiologic difference between these two kinds of mammals which could explain this difference? The most clear-cut dissimilarity between rats and mice on the one hand and bats on the other lies probably in the efficiency of their temperature control mechanisms. All Hollarctic Microchiroptera which have been investigated until now have been shown to be hemipoikilothermic, that is, the temperature of the individual essentially varies with that of the environment, but when activity is to take place thermoregulation at

TABLE 1. MAXIMUM LONGEVITY OF BATS.

| Species | (Years) Age Record | Locality | Reference |
|---|---|---|---|
| *MICROCHIROPTERA* | | | |
| *Myotis lucifugus* | 20.0 | USA, New England | Hall et al. (29b) |
| | 14.0 | USA, New England | Mohr, (41) |
| | 12.0 | USA, Illinois | Cockrum, (16) |
| *Myotis keenii* | 18.5 | USA, New England | Hall et al. (29b) |
| *Myotis mystacinus* | 13.5 | Belgium | Verschuren, 68) |
| | 10.0 | Belgium | Verschuren (68) |
| *Myotis myotis* | 13.0 | Netherlands | Bels (6) |
| | 12.0 | Germany | Eisentraut (21) |
| | 9.0 | France | Dorst (19) |
| | 7.5 | Belgium | Verschuren (68) |
| *Myotis sodalis* | 10.0 | USA, Kentucky | Mohr (41) |
| *Myotis subulatus* | 9.0 | USA, Pennsylvania | Mohr (41) |
| *Myotis nattereri* | 7.5 | Belgium | Verschuren (68) |
| *Myotis dasycneme* | 7.5 | Belgium | Verschuren (68) |
| *Rhinolophus ferrum-equinum* | 15.0 | France | Dorst (19) |
| | 14.5 | Netherlands | Bels (6) |
| *Rhinolophus hipposideros* | 13.5 | France | Dorst (19) |
| | 7.5 | France | Bourlière (8) |
| | 7.0 | Switzerland | Aellen (2) |
| *Miniopterus schreibersi* | 14.0 | France | Dorst (19) |
| *Pipistrellus subflavus* | 10.0 | USA, Wisconsin | Mohr (41) |
| | 7.0 | USA, Illinois | Cockrum (15) |
| *Eptesicus fuscus* | 9.0 | Canada, Ontario | Banfield (4) |
| | 9.0 | USA, Wisconsin | Mohr (41) |
| *Desmodus rotundus* | 12.5 | Panama, captivity | Trapido (66) |
| *MACROCHIROPTERA* | | | |
| *Roussettus leachi* | 19.5 | captivity | Flower (25) |
| *Pteropus giganteus* | 17.0 | captivity | Flower (25) |

optimum temperature is possible, at least within certain limits. The experiments of Burbank and Young (14), Eisentraut (20), Pearson (44) and Reeder (47) had already shown that during daily and seasonal periods of lowered metabolism the internal temperatures of bats closely approximated those of the environment. However, these data did not show the rate at which internal temperatures could follow or lag behind the ambient temperatures. This has now been ascertained by the experiments of Reeder and Cowles (48). Working in a temperature control chamber and recording both ambient and rectal temperatues through copper-constantin thermocouples, they were able to show that internal temperature of *Myotis velifer* (a migratory Californian species which goes southward during the cooler parts of the year) was able to fall to 5.8 C., with slight thermal lag, when the environmental temperature was lowered to 5 C. Another species *Macrotus californicus* (which does not migrate) had a better temperature control mechanism, maintaining its rectal temperature at 18 C. when that of the environment dropped to 5.7 C. Both species, nevertheless, were essentially poikilothermic, except during periods of activity. Even tropical fruit-bats seem to have a poor thermoregulation; the rectal temperature of an active *Rousettus angolensis* varied between 34.4 and 38.6 C., for an external temperature of 21 C. In the same conditions the internal temperature of a *Pteropus alecto* ranged between 31 and 37 C. Needless to say nothing alike occurs in adult rodents—except for the few species which hibernate in winter.

In birds we find a very similar situation. One of our most common European birds, the common swift *(Micropus apus),* has a very labile internal temperature. At night, after several days of bad weather and starvation, the young lose control of their body temperature, which falls nearly to that of their surroundings, sometimes dropping as low as 21 C. Such an adaptation helps the swift, which feeds only on aerial insects, to tide over periods of food shortages (Koskimies, 33). These birds have a lower mortality rate than any other wild bird so far studied on a large scale in Europe or North America (Lack, 35). Their mean length of life averages 4.5 years and one bird is known to have lived at least 17 years. Most song-birds living in the same environment have an expectation of life of no more than 1.5 years.

A few other birds are known to lose their temperature control and to become torpid each night. That is the case of the small hummingbirds, whose body temperature can fall as low as 8.8 C. (Bartholomew, Howell, and Cade, 5). We unfortunately have no data, at the present time, on their mortality rate and survival time in natural conditions, but at least one species *(Chlorostilbon aureoventris)* is known to have lived 8 years in captivity. Some caprimulgids also behave in much the same way.

*Body Temperature in the Aging Processes*

That temperature, both environmental for cold-blooded species and central for warm-blooded animals, has something to do with the rate of aging processes seems now most probable. But what can be the basic physiologic mechanism underlying this thermal effect?

The first explanation which comes to mind is that temperature acts through its accelerating effect on energy-turnover (Bourlière, 12). Fifty years ago Rubner (51) was the first to propose a definite relationship between rate of metabolism and duration of life. He believed that various mammals during their lifetimes used up approximately the same number of calories per unit of weight. As the smaller species have a much higher rate of metabolism per unit of weight than the larger forms, in order to preserve a constancy of body temperature, their duration of life should accordingly be shorter than that of bigger species and such is actually the case. Twenty years later, Pearl (43) and his associates provided the first experimental evidence supporting this point of view; as already mentioned earlier in this review, they were able to show that the life span of some invertebrates could be condensed or lengthened as the average metabolic rate was raised or lowered—through temperature changes or variation in food consumption. The recent observations on fishes, bats, and swifts are also very consistent with that point of view.

There are nevertheless some alternative possibilities which have been suggested recently. Sinex's (59) idea of a possible thermal denaturation of macromolecules, and especially of collagen and nucleic acids, is one. If such a phenomenon can take place in vivo, the more rapid aging of warm-blooded animals as compared with cold-blooded ones of similar size could easily be explained.

Another interesting suggestion has been

made by Failla (22). According to his hypothesis, aging could be due to a progressive accumulation of somatic mutations. As it is well known that an increase in temperature increases the spontaneous mutation rate in germ cells, the same phenomenon should likewise accelerate the rate of aging of somatic cells.

Certainly such hypotheses need to be confronted with positive experimental results before being considered as proved. They nevertheless emphasize how varied could be the action of a single physical factor on aging processes.

REFERENCES


1. Abeloos, M.: Recherches Expérimentales sur la Croissance et la Régénération chez les Planaires. *Bull. biol. France Belgique, 64:* 1-152, 1930.
2. Aellen, V.: Baguements de Chauve Souris dans le Jura Suisse. *Ornithol. Beobachter, 49:* 8-17, 1952.
3. Alpatov, W. W. and Pearl, R. Experimental Studies on the Duration of Life. XII. Influence of Temperature During the Larval Period and Adult Life on the Duration of Life in the Imago of *Drosophila melanogaster. Am. Nat., 63:* 37-67, 1929.
4. Banfield, A. W. F.: A Further Note on the Longevity of the Big Brown Bat. *J. Mammal., 31:* 455, 1950.
5. Bartholomew, G. A., Howell, T. R., and Cade, T. J.: Torpidity in the White-throated Swift, Anna Hummingbird and Poor-will. *Condor, 59:* 145-155, 1957.
6. Bels, L.: *Fifteen Years of Bat Banding in the Netherlands.* Publicaties van het Natuurhistorisch Genootschap in Limburg, *5:* 1-99, 1952.
7. Bennett, G. W.: The Growth of the Large-Mouthed Black Bass, *Huro salmoides* (Lacépède) in the Waters of Wisconsin. *Copeia,* 104-118, 1937.
8. Bourlière, F.: La Longévité des Petits Mammifères Sauvages. *Mammalia, 11:* 111-115, 1947.
9. Bourlière, F.: The Role of Comparative Physiology in Studies of Aging. In: *Problems of Aging.* Transactions of the Fifteenth Conference, January 20-22, 1953. Josiah Macy, Jr. Foundation: 126-196, 1954.
10. Bourlière, F.: *The Natural History of Mammals.* Knopf, New York, 1954.
11. Bourlière, F.: The Comparative Biology of Aging: a Physiological Approach. In *Ciba Foundation Colloquia on Ageing,* 3: 20-30, 1957.
12. Bourlière, F.: Ageing and Metabolism. In: *The Biology of Ageing.* Symposia of the Institute of Biology, n° 6: 27-33, 1957.
13. Brown, C. J. D.: Age and Growth of Montana Grayling. *J. Wildlife Manag., 7:* 353-364, 1943.
14. Burbank, R. C., Young, J. Z.: Temperature Changes and Winter Sleep of Bats. *J. Physiol., 82:* 459-467, 1934.
15. Cockrum, E. L.: Longevity in the Pipistrelle, *Pipistrellus subflavus subflavus. J. Mammal., 33:* 491-492, 1952.
16. Cockrum, E. L.: Homing, Movements and Longevity of Bats. *J. Mammal., 37:* 48-57, 1956.
17. Comfort, A.: *The Biology of Senescence,* Routledge and Kegan Paul, London, 1956.
18. Davis, D. E.: The Survival of Wild Brown Rats on a Maryland Farm. *Ecology, 29:* 437-448, 1948.
19. Dorst, J.: La Longévité des Cheiroptères. *Mammalia, 18:* 231-236, 1954.
20. Eisentraut, M.: Der Winterschlaf der Fledermäuse mit besonderer Berücksichtigung der Wärmeregulierung. *Ztshr. f. Morphol. Oekol. Tiere,* 29: 231-267, 1934.
21. Eisentraut, M.: Die mit Hilfe der Beringungsmethode erzielten Ergebnisse über Lebensdauer und jährliche Verlustziffern bei *Myotis myotis* Borkh. *Experientia, 3:* 157-158, 1947.
22. Failla, G.: The Biological Action of Ionizing Radiation, the Aging Process and Cancerogenesis. *American Institute of Biological Sciences Symposium,* Gatlinburg, Tenn., 1957.
23. Feldman-Muhson, B.: Studies on the Ecology of the Levant House Fly, *Musca domestica vicina. Bull. Entom. Res., 35:* 53-67, 1944.
24. Fischer-Piette, E.: Sur la Croissance et la Longévité de *Patella vulgata* L. en Fonction du Milieu. *J. Conchyl.; 83:* 303-310, 1939.
25. Flower, S. S.: Contributions to the Knowledge of the Duration of Life in Vertebrate Animals, V. Mammals. *Proc. Zool. Soc. London,* 145-234, 1931.
26. Fountaine, M. E.: Rapid Development of a Tropical Butterfly. *Entomologist, 71:* 90-91, 1938.
27. Frank, H., and Renner, O.: Über Verjüngung bei *Hedera helix L. Planta, 47:* 105-114, 1956.
28. Gerking, S. D.: Evidence of Aging in Natural Populations of Fishes. *Gerontologia, 1:* 287-305, 1957.
29. Gross, J.: Versuche und Beobachtungen über die Biologie der Hydriden. *Biol. Zentralblatt, 45:* 321-352, 385-417, 1925.

29b. Hall, J. S., Cloutier, R. J., and Griffin, D. R.: Longevity Records and Notes on Tooth Wear of Bats. *J. Mammal., 38:* 407-409, 1957.

30. Harrison, J. L.: Survival Rates of Malayan Rats. *Bull. Raffles Museum, Singapore, 27:* 5-26, 1956.
31. Heath, O. V. S.: Ageing in Higher Plants. In: *The Biology of Ageing,* Symposia of the Institute of Biology, n° 6, London, 9-20, 1957.
32. Klots, A. B.: *Vie et Moeurs des Papillons.* Horizons de France, Paris, 1957.
33. Koskimies, J.: On Temperature Regulation and Metabolism in the Swift, *Micropus a. apus* L., During Fasting. *Experientia, 4:* 274-282, 1948.
34. Krumholz, L. A.: Reproduction in the Western Mosquitofish *Gambusia affinis affinis,* and Its Use in Mosquito Control. *Ecol. Monogr., 18:* 1-43, 1948.
35. Lack, D.: *Swifts in a Tower,* Methuen, London, 1956.
36. Loeb, J., and Northrop, J. H.: On the Influence of Food and Temperature on the Duration of Life. *J. Biol. Chem., 32:* 103-121, 1917.
37. Mac Arthur, J. W., and Baillie, W. H. T.: Metabolic Activity and Duration of Life. 1. Influence of Temperature on Longevity in *Daphnia magna.* II. Metabolic Rates and Their Relation to Longevity in *Daphnia Magna. J. Exper. Zool., 53:* 221-242, 243-268, 1929.

38. Miller, R. B.: Notes on the Arctic Grayling, *Thymallus signifer* Richardson, from Great Bear lake. *Copeia,* 227-236, 1946.
39. Miller, R. B., and Kennedy, W. A.: Observations on the Lake Trout of Great Bear Lake. *J. Fish. Res. Bd. Canada, 7:* 176-188, 1948.
40. Molisch, H.: *The Longevity of Plants.* Authorized English edition by E. H. Fulling, New York, 1938.
41. Mohr, C. E.: A Survey of Bat Banding in North America, 1932-1951. *The American Caver, Bull. 14:* 3-13, 1953.
42. Oliver, J. A.: *The Natural History of North American Amphibians and Reptiles.* Van Norstrand, Princeton, 1955.
43. Pearl, R.: *The Rate of Living.* Knopf, New York, 1928.
44. Pearson, O. P.: The Rate of Metabolism of Some Small Mammals. *Ecology, 28:* 127-145, 1947.
45. Raitt, D. S.: The Fecundity of the Haddock. *Fishery Board for Scotland, Scientific Investigations,* no. 1, 1932.
46. Rasquin, P., and Hafter, E. Age-changes in the Testis of the Teleost *Astyanax mexicanus. J. Morphol., 89:* 397-407, 1951.
47. Reeder, W. G.: Hibernating Temperature of the Bat, *Myotis californicus-pallidus. J. Mammal., 30:* 51-53, 1949.
48. Reeder, W. G., and Cowles, R. B.: Aspects of Thermoregulation in Bats. *J. Mammal., 32:* 389-403, 1951.
49. Rizet, G.: Sur l'Impossibilité d'Obtenir la Multiplication Végétative Ininterrompue et Illimitée de l'Ascomycète *Podospora anserina. C. R. Acad. Sci., 237:* 838-840, 1953.
50. Robbins, W. J.: Physiological Aspects of Aging in Plants. *Am. J. Bot., 44:* 289-294, 1957.
51. Rubner, M.: *Das Problem der Lebensdauer und seine Beziehung zu Wachstum und Ernährung.* Oldenburg, Munich, 1908.
52. Rudzinska, M. A.: Overfeeding and Life Span in *Tokophrya infusionum. J. Gerontol., 7:* 544-548, 1952.
53. Rudzinska, M. A.: Differences Between Young and Old Organisms in *Tokophrya infusionum* (abstract). *J. Gerontol., 10:* 469, 1955.
54. Rudzinska, M. A.: Further Observations on the Fine Structure of the Macronucleus in *Tokophrya infusionum. J. Biophys. Biochem. Cytol., 2:* 425-430, 1956.
55. Rudzinska, M. A.: Changes in the Structure of the Cytoplasm in Old Organisms of *Tokophrya infusionum* as Revealed by Electron Microscopy. *J. Gerontol., 11:* 439-440, 1956.
56. Rudzinska, M. A.: Similarities Between Old and Overfed Organisms in *Tokophrya infusionum. Primer Congreso Panamericano de Gerontologia, México, Libro de Resúmenes,* 198-200, 1956.
57. Rudzinska, M. A., and Porter, K. R.: Observations on the Fine Structure of the Macronucleus of *Tokophrya infusionum. J. Biophys. Biochem. Cytol., 1:* 421-428, 1955.
58. Saint-Girons, M. C.: Contribution à la Connaissance de la Pachyure Étrusque en Captivité. *Mammalia, 21:* 69-76, 1957.
59. Sinex, F. M.: Aging and the Lability of Irreplaceable Molecules. *J. Gerontol., 12:* 190-198, 1957.
60. Sluiter, J. W., Van Heerdt, P. F., and Bezem, J. J.: Population Statistics of the Bat *Myotis mystacinus,* Based on the Marking-recapture Method. *Arch. Néerl. Zool., 12:* 63-88, 1956.
61. Sonneborn, T. M.: Genetic Studies on *Stenostomum incaudatum* (Nov. spec.) I. The Nature and Origin of Differences Among Individuals Formed During Vegetative Reproduction. *J. Exper. Zool., 57:* 57-108, 1930.
62. Sonneborn, T. M.: The Delayed Occurrence and Total Omission of Endomixis in Selected Lines of *Paramecium aurelia. Biol. Bull., 74:* 76-82, 1938.
63. Sonneborn, T. M., and Schneller, M.: Enormous Differences in Length of Life of Closely Related Ciliates and Their Significance. *American Institute of Biological Sciences Symposium, Gatlinburg, Tenn., 1957.*
64. Stroud, R. H.: Growth of the Basses and Black Crappie in Norris Reservoir, Tennessee. *J. Tenn. Acad. Sci., 23:* 31-99, 1948.
65. Terao, A., and Tanaka, T.: Duration of Life in the Water Flea *Moina macrocopa* Straus in Relation to Temperature. *J. Imp. Fish. Inst., 25:* 67, 1930.
66. Trapido, H.: Observations on the Vampire Bat with Special Reference to Longevity in Captivity. *J. Mammal., 27:* 217-219, 1946.
67. Van Oosten, J.: *Lake Trout.* U. S. Fish and Wildlife Service, Fish. Leaflet n° 15: 1-8, 1943.
68. Verschuren, J.: La Longévité des Cheiroptères en Belgique. Elements et Discussion. *Inst. R. Sci. Nat. Belgique, Bull., 31:* 1-8, 1956.
69. Weismann, A.: *Über die Dauer des Lebens.* G. Fisher, Jena, 1882.
70. Weismann, A.: The Duration of Life. In: *Essays upon Heredity and Kindred Biological Problems.* University Press, Oxford, 1891.
71. Woodruff, L. L.: Eleven Thousand Generations of *Paramecium. Quart. Rev. Biol., 1:* 436-438, 1926.
72. Woodruff, L. L.: *Paramecium aurelia* in Pedigree Culture for Twenty-five Years. *Tr. Am. Micros. Soc., 51:* 196-198, 1932.
73. Wooc uff, L. L.: The Pedigree Culture of *Paramecium aurelia* at Yale University. *Proc. Nat. Acad. Sci., 29:* 135-136, 1943.

# CLINICAL INVESTIGATIONS ON AGING PUBLISHED IN EUROPE AFTER THE SECOND WORLD WAR

TORBEN GEILL, M.D.
*(Medical Director, De Gamles By, Copenhagen)*

## INTRODUCTION

Since the last World War there has been an intensive activity in clinical geriatrics in Europe. A number of journals on geriatrics have brought contributions, and many other medical journals contain, to an increasing extent, publications of a geriatric nature. To these are added papers and reports at the numerous gerontologic and geriatric congresses, meetings, and symposia. Lastly, the large number of new manuals and textbooks on gerontology and geriatrics bear witness to the great interest in this field of medicine.

The survey to be given below is far from complete. The limited time at my disposal did not permit an exhaustive review of the literature. Many papers pertaining to geriatrics are not published in a well-known language and are, consequently, not directly accessible. Nevertheless, it is my hope to convey the impression that European scientists in geriatrics are particularly active and to facilitate the interested reader's contact with the papers listed in the references.

## DISORDERS OF BLOOD COAGULATION

In recent years great interest has been displayed in the coagulation of the blood. Important contributions have come from Great Britain, Italy, Germany, and Scandinavia. The main question is to what extent disturbances of coagulation occur, as it must be taken for granted that changes of the vessel walls, arterial as well as venous, and of the mechanism of circulation are the most important factors in causing thrombi and emboli.

In a large material obtained at autopsy at De Gamles By (The Geriatric Hospital), Copenhagen, Bruzelius (4) found fresh infarctions in 4.1% and sequelae of coronary occlusion (major myofibroses) in 20.7%. Thrombosis of the venous system, particularly emboli and thrombi of the pulmonary artery, seem to have become considerably more common than previously (Brull, 5). According to Geill (12), a geriatric autopsy series from De Gamles By showed emboli and thrombi of the pulmonary artery in 23.7%.

Greppi (15) has reported that plethoric individuals exhibit capillary brittleness and a tendency to thrombosis caused by a shortened clotting time. Scardigli and Guidi (24), studying patients with thrombophilic diathesis (diabetes mellitus, atherosclerosis, hypertension, plethora, arteritis), found that the majority of the subjects had increased cholesterolemia, an increase in all blood lipids and "of the beta/alpha lipoprotein ratio," as well as an increase in prothrombin activity, proconvertin, and proaccelerin, in addition to a reduced blood level of heparin and antithrombin. These changes entail hypercoagulability with a tendency to thrombus formation.

Geill (13) has studied the recalcification time of the blood plasma by H. C. Gram's modification of the Howell method. While in youngish, normal persons the clotting time was close to 3 minutes, elderly subjects showed a marked dispersion with numerous low values. Investigations by the original Howell method, performed by Alessandri (1) and Zarban (28), have shown a shortened recalcification time in old age. In contrast, Schulz (26) found an unmistakable prolongation of the recalcification time of total blood with advancing age; Ehrenberg and Köppen (7) observed a corresponding prolongation of the clotting time (in blood samples obtained from the finger pulp). According to Geill (14), investigations into thrombin formation by Biggs and MacFarlane's (2) thrombin generation test show that thrombin formation increases in the presence of hematomas and hemorrhages in the tissues as well as following intramuscular injections of blood. This increase may be due to an increased flow of thromboplastin from the tissues or possibly also to posthemorrhagic thrombocytosis. As a contrast, the thrombin formation was found to be considerably reduced in patients with liver cirrhosis (fig. 1). Corresponding to these biochemical changes, cirrhosis of the liver is much more rarely accompanied by pulmonary emboli

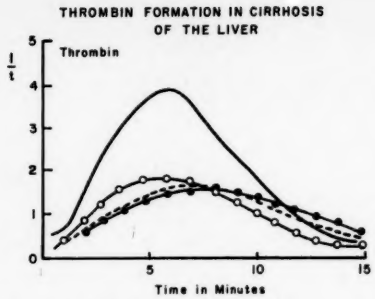


Fig. 1. Thrombin Formation in Cirrhosis of the Liver.
——— Normal youngish individual,
○——○ 77-year-old woman with cirrhosis of the liver. Prothrombin-proconvertine concentration (P-P value after Owren and Aas, 23) 52%.
..... 70-year-old man with cirrhosis of the liver. P-P value 60%.
●——● 74-year-old woman with cirrhosis of the liver. P-P value 80%.

and thromboses. In a large autopsy series of hepatic cirrhosis, thrombotic complications were observed in only 11.5% as compared with 24.5% in the general autopsy material.

The fibrinogen content of the blood (measured by precipitated fibrin) has been studied by Schulz (26), who reports that it increases with advancing age (fig. 2). Köppen (18) found a simultaneous increase of serum globulin. Since, according to Schulz, fibrinolysis decreases materially with advancing age, the main reason of the increased thrombus formation in old age is in his opinion the combination of increased fibrinogen content and reduced fibrinolysis.

Thus, the factors which increase the incidence of thrombosis in old age are extremely complicated, some being involved in coagulation and other in fibrinolysis. Diseases, both acute and chronic, as well as therapeutic interventions (operations, medication) may interfere with two systems. From-Hansen and his associates, (9) have treated patients suffering from thrombosis of the coronary, retinal, pulmonary, and femoral arteries as well as patients with thrombophlebitis by intravenous infusions of a plasminogenic activator extracted from human urine. In a highly purified state, it did not give rise to side effects. This treatment resulted in free fibrinolytic activity in the blood; in vitro the blood could dissolve coronary thrombi, removed post mortem, in the course of 1 or 2 hours. The number of observations is, however, too small to evaluate the clinical effect.

It must be endeavored, therefore, to develop simple methods for disclosing a tendency to thrombosis, particularly in elderly persons, in order to initiate prophylactic measures in time. The importance of such prophylaxis is indicated by the modern long-term treatment with anticoagulants of the dicumarol type. According to Dalsgaard-Nielsen and Skinhøj (6) who treat cerebral thrombosis with anticoagulants, this therapy lowers the mortality from about 30% to 5.8%. The lowered mortality seems to be caused by a reduction in the occurrence of thromboses in the venous system with subsequent emboli to the pulmonary arteries. For three years, Faber and Geill (8) have been treating 50 patients in De Gamles By, Copenhagen, by injections of heparin, in order to elucidate the possible lipolytic effect of this drug. The treated patients did not live longer than the control series, and the cholesterol deposits were the same as in the control material. Schulz (26), who considers the increased concentration of fibrinogen in the blood combined with the reduced fibrinolysis in old age to be the main causes of thrombosis, suggests a treatment aiming at increased fibrinolytic activity.

Numerous studies have demonstrated that the dietary content of fats may entail an increased coagulability of the blood. MacFarlane, Trevan, and Attwood, (19) Fullerton and Anastasopoulos (10) were the first to demonstrate that certain samples of lecithin were accelerators of blood clotting. According to Waldron, Beidelman, and Duncan (26), Fullerton, Davie, and Anastasopoulos (11), O'Brien (21), Hall (17), Scardigli, Guidi, and Salvini (23) fatty meals exert the same effect. More detailed differentiation between the effect upon coagulation by the various kinds of fat was performed by

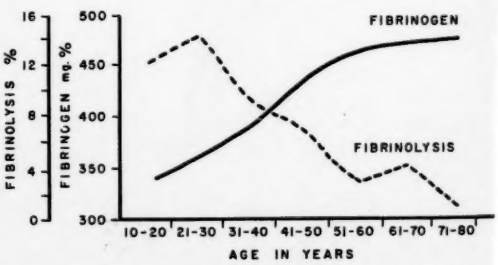


Fig. 2. Fibrinogen and Fibrinolysis in Various Age Periods (after Schulz, 26).

MacLagan and Billimoria (20), who found that butter perceptibly shortened the clotting time, while margarine did not. These studies were later continued by Billimoria, Lockey, and MacLagan (3), using a number of different clotting methods, viz., the Russell viper venom accelerated clotting time ("Stypven" time) of platelet-poor plasma, the plasma recalcification time, and the whole blood recalcification time. Only foods containing milk fat gave strongly positive results, other fatty foods being relatively inactive. By the venom technique it was shown that at optimum concentrations butter caused an 80% shortening of the clotting time as compared with only 18% by margarine. Similar effects were obtained in the recalcification of plasma and of whole blood, although the percentage changes in clotting time were somewhat smaller. Using the "Stypven" method, O'Brien (22) found no correlation between changes in clotting time and in the amount of total fatty acids and only poor evidence that considerable changes in clotting time were associated with an increase in total phospholipids. It is concluded that probably the degree of saturation of ingested fats is immaterial to the postprandial changes in clotting time. Fats containing short chain fatty acids may have a different effect from those with long chain fatty acids. A meal of phospholipids shortens the "Stypven" time much more than a meal of triglycerides.

The Italian workers Guidi, Salvini, and Scardigli (16) have demonstrated that butter as well as olive oil shortens the clotting time, whereas margarine has no perceptible influence. As clotting methods they used Lee-White's and Howell's techniques.

The conflicting results which have been reported must be attributed in part to the different nature of the clotting methods and in part to the fact that from the point of view of fat, the product sold as margarine is of such widely different nature.

## REFERENCES


1. Alessandri, R.: Prime Ricerche sul Tempo di Quick e sul Tempo di Howell in un Gruppo di Senescenti. *Giorn. Gerontol., 2:* 270-272, 1954.
2. Biggs, R., and MacFarlane, R.: *Human Blood Coagulation and Its Disorders.* Blackwell Scientific Publications, Oxford, 1953.
3. Billimoria, J., Lockey, E., and MacLagan, N.: Some Observations on the Effect of Fats on Blood Clotting. *Proc. Roy. Soc. Med., 50:* 623-626, 1957.
4. Bruzelius, K.: Lokalisationens Betydning for Hjærteinfarkternes Prognose. *Nord. med. 46:* 1231-1232, 1951.
5. Brull, L.: Discussion. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, p. 270.
6. Dalsgaard-Nielsen, T., and Skinhøj, E.: Anticoagulant Treatment in Cerebral Thrombosis. *Sixth European Hematological Congress, Copenhagen, 1957.*
7. Ehrenberg, R., and Köppen, E.: Der Altersgang der Blutgerinnung. *NaturWissensch., 39:* 215, 1952.
8. Faber, M.: Prophylactic Treatment of the Obliteration of the Aortic Bifurcation. *Minerva cardioang. Europ., 5:* 1-7, 1957.
9. From-Hansen, P., Jørgensen, M., Ploug, J., and Kjeldgaard, N.: Human Urine Activator Used in Coronary Thrombosis. In press.
10. Fullerton, H., and Anastasopoulos, G.: Anticoagulant Therapy. *Brit. M. J., 2:* 1492-1495, 1949.
11. Fullerton, H., Davie, W., and Anastasopoulos, G.: Relationship of Alimentary Lipaemia to Blood Coagulability. *Brit. M. J., 2:* 250-253, 1953.
12. Geill, T.: Studies on Blood Coagulation in Old Age. Pulmonary Thrombosis and Embolism in Cirrhosis of the Liver. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 267-269.
13. Geill, T.: Studies on Blood Coagulation in Old Age (Using the Howell-Gram Plasma Recalcification Method). *Acta Med. Leg. Soc., 9:* 65-75, 1956.
14. Geill, T.: Studies on Blood Coagulation in Old Age. Thrombin Formation Following Haematomas and Traumatic Injuries of the Tissues. *Fourth Congress, International Association of Gerontology, Merano, 1957. Abstracts,* p. 142.
15. Greppi, E.: Simultaneous Trombophilic and Hemorrhagic Signs in Senile Vascular Pathology. *Fourth Congress, International Association of Geronotology, Merano, 1957. Abstracts,* p. 153.
16. Guidi, G., Salvini, L., and Scardigli, G.: Carico Lipidico Animale e Vegetale in Soggetti Normali ed Ateroslerotici. *Fourth Congress, International Association of Gerontology, Merano, 1957. Abstracts,* p. 156.
17. Hall, G.: Reassessment of Effect of Fatty Meals on Blood Coagulability. *Brit. M. J., 2:* 207-209, 1956.
18. Köppen, E.: *Vergleichende Untersuchungen des Blutserums und Aszites.* Dissertation. Leipzig, 1942.
19. MacFarlane, R., Trevan, J., and Attwood, A.: Participation of a Fat Soluble Substance in Coagulation of the Blood. *J. Physiol., 99:* p. 7-8, 1941.
20. MacLagan, N., and Billimoria, J.: Food Lipids and Blood Coagulation. *Lancet, 271:* 235-236, 1956.
21. O'Brien, J.: Effect of a Meal of Eggs and Different Fats on Blood Coagulation. *Lancet, 271:* 232-234, 1956.
22. O'Brien, J.: Some Postprandial Effects of Eating Various Phospholipids and Triglycerides. *Lancet, 272:* 1213-1216, 1957.
23. Owren, P., and Aas, K.: The Control of Dicumarol Therapy and the Quantitative Determination of Prothrombin and Proconvertin. *Scandinav. J. Clin. & Lab. Invest., 3:* 201-208, 1951.

24. Scardigli, G., and Guidi, G.: L'Evolution de la Diathèse Thrombophilique. *First International Conference on Thrombosis and Embolism, Basel, 1954.* T. Koller and W. Merz, eds. Schwabe & Co., Basel, 1955, pp. 459-462.
25. Scardigli, G., Guidi, G., and Salvini, L.: Gli Stati Trombofilici e il Trattamento Anticoagulante. *Giorn. Gerontol., Supp. 8:* 1-280, 1956.
26. Schulz, F.: Gerinnungs- und Blutstillungsfaktoren in verschiedenen Altersstufen und ihre Bedeutung für die Thromboseentstehung. *First International Conference on Thrombosis and Embolism, Basel, 1954.* T. Koller and W. Merz, eds. Schwabe & Co., Basel, 1955, pp. 463-467.
27. Waldron, J., Beidelman, B., and Duncan, G.: Local and Systemic Effects of Cream and Blood Coagulation. *Gastroenterol., 17:* 360-366, 1951.
28. Zarban, M.: Fragilità Capillare, Tempo di Coagulazione e Tempo di Sanguinamento nella Vecchiaia. *Giorn. Gerontol., 2:* 307-314, 1954.

## ARTERIOSCLEROSIS

In Europe, the study of arteriosclerosis has been on the same lines as in U.S.A., and in Europe too opinions differ as to its main cause:

*(1) Significance of Nutrition.*

According to a number of European workers, disturbances in the cholesterol metabolism, especially with a diet too high in cholesterol and animal fat, is the cause of atherosclerosis. It is interesting to consider the findings in the Scandinavian countries during the last World War and the first post-war years. In Finland (Vartiainen and Kanerva, 44), Sweden (Malmros, 34, 35, 36, Henschen 26), and Norway (Dedichen, Strøm, and Jensen, 12) the mortality from arteriosclerotic diseases, particularly cardiac diseases, decreased during these years in which nutritive restrictions involved a marked reduction in the consumption of eggs, butter, and fat meat. In agricultural Denmark, the population had, despite the restrictions due to the presence of German troops, rations of eggs, milk, butter, and pork, which considerably exceeded those in the other Scandinavian countries. Consequently, such a fall in the mortality from atherosclerotic lesions was not observed in Denmark. The increasing consumption of the above-mentioned animal products during the post-war years has again raised the mortality from those diseases in the Scandinavian countries.

The role of the food in cholesterol metabolism has been shown by a large number of European publications. As in similar studies from U.S.A., Canada, and South Africa, it has been demonstrated that most animal fats increase the cholesterol level of the blood, whereas vegetable fats as a rule do not and in many cases even reduce this level (Groen and associates, 24; Greppi and associates 21, 22; Scardigli, Guidi, and Salvini, 40; Coppo, Lorenzini, and Innocenti, 11; Barbareschi, 7; and Malmros and Wigand, 35, 36). The continued studies of the two last mentioned authors (35, 36) are of particular interest. While most previous authors have based their investigations on short experiments, Malmros and Wigand followed their subjects for up to one year. Each of their subjects, who were reported to be healthy, received 150 Gm. of some fat daily, constituting about 40% of the total calorie content. The use of vegetable fats showed that corn oil and safflower seed oil had a markedly depressing effect on the serum cholesterol. Rape-seed oil had a moderate effect, and olive oil only a slight effect. Coconut fat (both hydrogenated and non-hydrogenated) had no effect at all (fig. 3). Among the animal fats, milk fat showed an enhancing effect on the cholesterol level, while whale oil depressed it. This last fat can hardly be used for human consumption in a non-hydrogenated form, and if it is hydrogenated it loses its cholesterol-depressing effect. The authors conclude from their experiments that the cholesterol-depressing effect of certain fats is related to their content of polyunsaturated fatty acids.

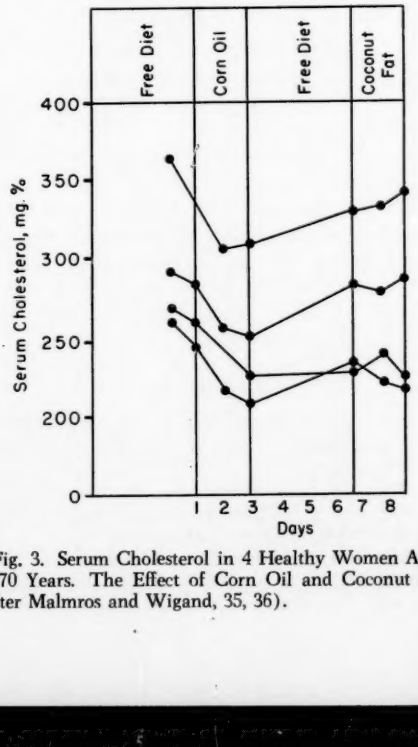


Fig. 3. Serum Cholesterol in 4 Healthy Women Aged 62-70 Years. The Effect of Corn Oil and Coconut Fat (after Malmros and Wigand, 35, 36).

In order to make corn oil and other fats with a cholesterol-depressing effect palatable and acceptable to the patients, Malmros and Wigand (36) prepared some artificial dairy products, such as "milk," "cheese," and "ice cream." Nineteen patients with essential hyper-cholesterolemia were treated over a long period, 14 of them for more than a year. They received pure corn oil and artificial dairy products made from the oil as well as a basic diet consisting of bread, cereals, vegetables, potatoes, rice, fruit, sugar, and in some cases lean meat and fish. The serum cholesterol regularly fell within two weeks. In many cases, the cholesterol then remained at a low level. One of the patients was almost refractory to the treatment. Other cases of hypercholesterolemia of an unusual type also reacted favorably to the treatment with corn oil.

Greppi and associates (23), after single meals of 250 Gm. bread, 200 Gm. meat, 50 Gm. olive oil, and 50 Gm. butter, respectively, administered to normal elderly subjects and to atherosclerotics, found that the 3 last-mentioned foods exerted a detrimental effect on the lipid metabolism and blood coagulation. They add: "Si nous pensons à l'horaire normal des répas dans la vie des populations du Nord et du Centre de l'Europe (3-4 répas en 12 heures avec un bon percentage de proteines et de graisses) nous pouvons réfléchir sur la probable responsabilité de l'alimentation riche moderne dans le développement des troubles metaboliques de nôtre type."

(2) *Other Causes: disturbances in the coagulation mechanism, hemodynamic factors.* Duguid (13) (Newcastle), in 1948, advanced his hypothesis that atheromatosis starts as mural thromboses which later become organized and overgrown with epithelium. In his opinion, lipid deposits on the vessel wall with secondary overgrowth of endothelium may give rise to similar thickenings of the intima. Later, calcium salts are deposited. Such repeated mural thrombi and subsequent organization lead to considerable narrowing of the vascular lumina. Harrison (25) has supported Duguid's hypothesis by experiments, injecting fibrin into the pulmonary arteries of rabbits. The resulting arterial changes were indistinguishable from atheromatosis. In later papers by Duguid (14) and Duguid and Robertson (15) this hypothesis has been elaborated. The changes encountered in the coronary arteries, particularly in elderly persons, are due to mural thrombi and central thrombi; the latter become recanalized. Coronary disease is not quite the same as atherosclerosis. There may be severe atherosclerosis of the coronary arteries without any narrowing, just as there may be fatal narrowing without much atherosclerosis. According to Duguid and Robertson (15), the uncomplicated or simple atherosclerosis is a very different problem. Although thrombosis plays a part in its development, it is a relatively benign part, and mechanical factors ("wear and tear") must be taken into consideration.

In conection with Duguid's theory, there is reason to emphasize Koller's (31) demonstration of a relationship between arteriosclerosis and thrombosis. In the presence of arterial narrowing, congestion will occur proximal to the stenosis. At this site, an epithelial defect with an afflux of tissue thromboplastin can start a clotting process. The same seems to take place merely as a consequence of the concentration of blood platelets along the vascular wall due to the congestion. It has been demonstrated that necrosis is not necessary, but that the very presence of the platelets is sufficient to induce clotting. In any event, the result is thrombosis as a complication of the atherosclerosis.

According to Faber and Lund (17), the deposition of lipids in the aortic wall is not related to nutrition. Quantitative determinations of the cholesterol content of the human aorta showed that the deposition was a function of the subject's age and the level of the blood pressure. There was an approximate proportionality between the cholesterol deposit and the degree of hypertension. In diabetes mellitus, which is accompanied by high blood cholesterol levels, the cholesterol content of the aortic wall was not distinctly increased. In pathologic studies, Büchner (10) too has found that hypertension is the main cause of atherosclerosis in the aorta and coronary arteries. Hirsch (28) also stresses the point of view that arteriosclerosis is caused primarily by hemodynamic factors.

A large number of investigations have been concerned with the concentration of cholesterol, proteins, lipoproteins, mucoproteins, etc., in the blood in the different age groups, especially in elderly subjects with or without manifest atherosclerosis. In general, it is not stated whether the disturbances seen in the blood chemistry are 1) the cause of the atherosclerosis, 2) a

sequel of atherosclerosis, or 3) just an associated phenomenon. A comprehensive review on cholesterol metabolism has been published by Barbareschi (7). Other studies have been reported by Biörck, Blomquist, and Sievers (8), Biörck and Karni (9); Ejrup (16); Malmros, Biörck, and Swahn (34); Lindholm (32), and Welin (43). The effects of sitosterol have been investigated by Kalliomäki, Waris, and Vasama (30). In certain cases at least a depression of the blood cholesterol level may be obtained in patients with hypercholesterolemia, whereas consistent changes in total lipids and liproproteins have not been observed.

Herbeuval and associates (27), studying the distribution of the protein fractions in the blood of 200 aged subjects, found a decrease in the albumin fraction and an increase in the globulin fractions. Nöcker (38) reports that among the serum proteins the alpha 1 globulin fraction remains practically unchanged throughout the years, whereas the alpha 2 globulin, the beta globulin, and the gamma globulin increase in advanced age. The increase in beta globulin seems to be most marked. According to Nöcker these changes in proteins represent the biologic tissue changes which take place throughout life (Bürger's biomorphosis). Investigating serum proteins and lipoproteins, Antonini and Salvini (4), Antonini, Piva, Salvini, and Sordi (6), did not find distinct alterations in the protein pattern of the serum, although they did find changes in the lipoprotein pattern. Paper electrophoretic experiments showed in arteriosclerotics an increase in the slow fractions (beta liproprotein) and a depression of the fast fractions (alpha lipoprotein). In normal aged persons Rossi (39) found lipoprotein curves which did not differ materially from those representing healthy, young subjects.

Glycoproteins and mucopolysaccharides have been investigated by Antonini (1) and by Antonini and Mininni (2), who observed enhanced values in elderly subjects, particularly those with arteriosclerosis. On the other hand, Galletti, Abbati, and Faggioni (19) report that healthy old persons often exhibit higher values than younger persons, whereas patients with degenerative diseases often show normal values.

Most workers are agreed that administration of heparin can normalize the blood picture in elderly persons (Antonini (1); Antonini, Piva, Salvini, and Sordi (6); Antonini and Sordi (5); Antonini and Piva (3); Coppo, Lorenzini, and Innocenti (11)). Galletti and Abbati (18), on the other hand, did not find any alterations in the concentration of serum glycoproteins in elderly persons within the first 4 hours after intravenous injection of 100 mg. heparin.

Morabito (37) reported that serum phosphorus is increased and serum phosphatases, particularly the acid ones, are reduced in old age. According to Torre and associates (41) free amino acids in the blood do not change with advancing age, but an increase takes place in the amino acid content of the red blood cells.

Studies on the role of lipoperoxides in human pathology have been carried out by Glavind and associates (20). While normal aortae did not contain lipoperoxides, peroxides were found in the lipid of all the samples of atherosclerotic aortae that were examined.

A negative correlation between atherosclerosis and carcinoma was demonstrated by Wanscher, Clemmesen, and Nielsen (42). Atherosclerotic lesions of the aorta and coronary arteries were less pronounced in patients with than without cancer. A more thorough study into this problem was carried out by Juhl (29), who perused the postmortem records of 12,355 patients, 3,725 of whom had malignant tumors. Atherosclerotic lesions in the aorta and coronary arteries were significantly less pronounced in persons suffering from malignant diseases than among persons without such diseases. This phenomenon seems to be present in cases of malignant tumors irrespective of site or histologic type. Men with bronchial carcinoma, like other cancer patients, show less pronounced atherosclerotic lesions than controls, but more pronounced than other cancer patients. Both differences were statistically significant. It is assumed that in some way or other, the presence of malignant tumors inhibits the development of atherosclerosis. Possibly, the cause of this inhibition is related to the role of cholesterol or its derivatives in the development and growth of malignant tumors (increased accumulation of cholesterol in tumors and precancerous tissue). It must be pointed out, however, that these authors did not take the weight and nutritional status of the patients into consideration. Since empirically, cancer patients have a poor appetite and become emaciated, it would seem more natural to relate the rare development of atherosclerosis in such pa-

tients to the reduced intake of food, especially of animal products.

The influence of the sex hormones on the development of atheromatosis has been studied by Magrini (33), who thinks that the sex difference in the incidence of atherosclerosis is caused by a difference in the concentration and distribution of the plasma lipids in the two sexes, especially up to old age. His findings permit the presumption that ovarian function is the main factor which protects premenopausal women from atherosclerosis. During estrogen therapy, Magrini observed that in patients with a history of myocardial infarction the lipoprotein pattern—already shifted to the atherogenic side—showed a tendency to become normalized and took on an appearance characteristic of young people. Testosterone, on the other hand, gave pronounced atherosclerotic changes in the plasma lipoprotein pattern.

## AUTHOR'S COMMENTS

The European studies reviewed above afford evidence that the development of atherosclerosis is due in the main to nutritional factors, chiefly the presence of saturated fatty acids and cholesterol in the food, but that other factors too, particularly hypertension, are of decisive significance. The intimate correlation between arteriosclerosis and thrombus formation in the arteries has been further established by a number of investigators. In future studies on the pathogenesis of arteriosclerosis, increased regard must be paid, therefore, to the triad arteriosclerosis-blood coagulation-thrombosis.

## REFERENCES


1. Antonini, F.: Biochemical Changes in Blood in Atherosclerosis and in Old Age with Particular Reference to Mucopolysaccharides and Heparinoid Substances. In: *Experimentelle Alternsforschung*, F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, pp. 176-180.
2. Antonini, F., and Mininni, G.: Metabolismo dei Mucopolissaccaridi nell'Aterosclerosi Sperimentale da Colesterolo. *Giorn. Gerontol., 2:* 649-652, 1954.
3. Antonini, F., and Piva, G.: Sull'Effetto in Vivo dell'Eparina e del Solfato di Protamina sulle Lipoproteine del Plasma Umano. *Giorn. Gerontol., 1:* 229-239, 1953.
4. Antonini, F., and Salvini, L.: Applicazione dell'Elettreforesi su Carta allo Studio del Metabolismo Proteico e Lipoproteico nell'Atero-sclerosi Umana. *Giorn. Gerontol., 1:* 207-218, 1953.
5. Antonini, F., and Sordi, A.: Sull'Azione dell'Eparina e del Solfato di Protamina sulla Lipemia del Plasma Umano nel Normale e nell'Aterosclerotico. *Giorn. Gerontol., 1:* 219-228, 1953.
6. Antonini, F., Piva, G., Salvini, L., and Sordi, A.: Lipoproteine ed Eparina nel Quadro Umorale delle Chemiopatogenesi dell'Alterosclerosi. *Giorn. Gerontol., Suppl. 1:* 1-91, 1953.
7. Barbareschi, G.: Il Metabolismo del Colesterolo. *Giorn. Gerontol., 2:* 354-370, 1954.
8. Biörck, G., Blomquist, G., and Sievers, J.: Cholesterol Values in Patients with Myocardial Infarction and in a Normal Control Group. *Acta med. scandinav., 156:* 493-497, 1957.
9. Biörck, G., and Karni, H.: Serum Cholesterol Values in Cardiac Patients. *Nord. med., 38:* 1175-1179, 1948.
10. Büchner, F.: Chronische Hypertonie als ein Faktor in der Entstehung der Arteriosklerose. In: *Symposium on Arteriosclerosis, Basel, 1956.* Schwabe & Co., Basel, 1957, pp. 127-138.
11. Coppo, M., Lorenzini, R., and Innocenti, E.: Alcuni Effetti del Pasto Graso e dell'Eparina sul Lipodogramma "ef" in Sogetti Giovani e in Aterosclerotici. *Giorn. Gerontol., 4:* 599-630, 1956.
12. Dedichen, J., Strøm, A., and Jensen, A.: Incidence of Atherosclerotic Disease During War Years. *Transactions of the Fifth Conference on Factors Regulating Blood Pressure,* Josiah Macy, Jr., Foundation New York, 1951, pp. 117-123.
13. Duguid, J.: Thrombosis as Factor in Pathogenesis of Aortic Atherosclerosis. *J. Path. & Bact., 60:* 57-61, 1948.
14. Duguid, J.: The Pathogenesis of Arterial Narrowing. In: *Symposium on Arteriosclerosis, Basel, 1956.* Schwabe & Co., Basel, 1957, pp. 73-80.
15. Duguid, J., and Robertson, W.: Mechanical Factors in Atherosclerosis. *Lancet, 272:* 1205-1209, 1957.
16. Ejrup, B.: Intermittent Claudication in Thrombosis of the Aorta and Iliac Arteries. *Acta med. scandinav., Suppl. 308:* 41-42, 1955.
17. Faber, M., and Lund, F.: The Human Aorta. *Arch. Path., 52:* 239-243, 1951.
18. Galletti, F., and Abbati, A.: Eparina e Arteriosclerosi: Variazioni delle Glicoproteine Sieriche sotto Carico Eparinico Acuto. *Giorn. Gerontol., 5:* 679-683, 1957.
19. Galletti, F., Abbati, A., and Faggioni, A.: Le Glicoproteine Seriche nell'Età Senile. *Giorn. Gerontol., 4:* 631-642, 1956.
20. Glavind, J., Hartmann, S. Clemmesen, J., Jøssen, K., and Dam, H.: Studies on the Role of Lipoperoxides in the Human Pathology. II. The Presence of Peroxidized Lipids in the Atherosclerotic Aorta. *Acta path. et microbiol. scandinav., 30:* 1-6, 1952.
21. Greppi, E.: Fattori Constituzionali ed Umorali nel Complesso Metabolico e Vascolare dell'Età Presenile ("Ateromasia"). In: *Symposium on Arteriosclerosis, Basel, 1956.* Schwabe & Co., Basel, 1957, pp. 139-146.
22. Greppi, E., (e compagni della Clinica Medica Generale dell'Università di Firenze): L'Aterosclerosi. *Giorn. Gerontol., 5:* 649-659, 1957.
23. Greppi, E., Scardigli, G., Salvini, L., and Guidi, G.: Effects de Certaines Charges Alimentaires sur le Métabolisme des Anciens et des Athérosclérotiques. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 170-175.

24. Groen, J., Tjiong, B., Kamminga, E., and Willebrands, A.: The Influence of Nutrition, Individualizing and Some Other Factors, Including Various Forms of Stress, on Serum Cholesterol; an Experiment of Nine Months' Duration in 60 Normal Human Volunteers. *Voeding, 13:* 556-587, 1952.
25. Harrison, C.: Experimental Pulmonary Arteriosclerosis. *J. Path. & Bact., 60:* 289-293, 1948.
26. Henschen, F.: Geographic and Historical Pathology of Arteriosclerosis. *J. Gerontol., 8:* 1-5, 1953.
27. Herbeuval, R., Cuny, G., Manciaux, M., and Hansen, J.: The Study of the Distribution of Blood Protein Fractions in 200 Aged Subjects. In: *Old Age in the Modern World,* E. and S. Livingstone Ltd. London, 1955, p. 574.
28. Hirsch, S.: Etude Histologique des Stades Initiaux de l'Artériosclérose et Quelques Conclusions Pathogéniques Qui s'en Dégagent. *Bull. Acad. Suisse Scs. Méd., 13:* 93-107, 1957.
29. Juhl, S.: Cancer and Atherosclerosis. *Acta path. et microbiol. scandinav., 37:* 167-181, 1955.
30. Kalliomäki, J., Waris, E., and Vasama, R.: The Effects of Sitosterols on Total Serum Cholesterol and on Serum Lipoproteins in Man. *Nord. med., 57:* 460-463, 1957.
31. Koller, F.: Arteriosklerose und Thrombogenese. In: *Symposium on Arteriosclerosis, Basel, 1956.* Schwabe & Co., Basel, 1957, pp. 81-92.
32. Lindholm, H.: Serum Lipids in Normal Adults. *Acta med. scandinav., 157:* 205-208, 1957.
33. Magrini, D.: Aterosclerosi e Sesso. *Giorn. Gerontol., 5:* 73-98, 1957.
34. Malmros, H., Biörck, G., and Swahn, B.: Hypertension, Atherosclerosis and the Diet. *Acta med. scandinav., Suppl. 312:* 71-78, 1956.
35. Malmros, H., and Wigand, G.: Die Einwirkung gewisser animalischer und vegetabilischer Fettstoffe auf die Serumlipoide. In: *Symposium on Arteriosclerosis, Basel, 1956.* Schwabe & Co., Basel, 1957, pp. 315-328.
36. Malmros, H., and Wigand, G.: The Effect of Serum-Cholesterol of Diets Containing Different Fats. *Lancet, 273:* 1-7, 1957.
37. Morabito, A.: Fosforo, Fosfatasi Alcalina e Acida nel Siero dei Vecchi. *Giorn. Gerontol., 2:* 267-269, 1954.
38. Nöcker, J.: Die Alternswandlungen der Serumeiweisskörper. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 188-193.
39. Rossi, A.: Applicazione dell'Elettroforesi su Carta per 10 Studio delle Lipoproteine nel Siero dei Vecchi. *Giron. Gerontol., 2:* 262-266, 1954.
40. Scardigli, G., Salvini, L., and Guidi, G.: Effects de Quelques Charges Alimentaires sur les Indicateurs Humorales de la Maladie Athérosclérotique. *Compt. rend. Journ. Therapeut.,* Paris, 1955.
41. Torre, M., Baggio, G., Scarzella, R., and Zanalda, A.: Gli Aminoacidi Liberi del Sangue in Soggetti di Varia Età Studiati con Metodo Cromatografico. *Gior. Gerontol., 2:* 389-396, 1954.
42. Wanscher, O., Clemmesen, J., and Nielsen, A.: Negative Correlation Between Atherosclerosis and Carcinoma. *Brit. J. Cancer, 5:* 172-174, 1951.
43. Welin, G.: Om Serumkolesterinet vid Hjärtinfarkt. *Nord. med., 37:* 324-326, 1948.
44. Vartiainen, I., and Kanerva, K.: Arteriosclerosis and War-time. *Ann. med. int. Fenniae, 36:* 748-758, 1947.

## THE VASCULAR SYSTEM

An interesting investigation into age variations in blood pressure has been performed by Bøe, Humerfelt, and Wedervang (3) in Bergen, Norway. As a link in a general tuberculosis case-finding survey involving the entire population of the town, they measured the blood pressure in nearly 68,000 persons. The systolic blood pressure was found to increase more rapidly with age in women than in men, starting at a lower level in the younger age groups and ending at a higher level in the older age groups. In the oldest age groups, this increase tended to level out, indicating that an elevated blood pressure may be related to excess mortality. On the basis of the distribution curves, it is not possible to determine where a blood pressure "normal" for the age group ceases and where an abnormal blood pressure begins. A very interesting result of this analysis was the apparently slight influence of overweight. For each 10 Kg. in body weight the systolic blood pressure was raised by only about 3 mm. Hg. and the diastolic pressure by only 2 mm. Hg. As the blood pressure reading in an obese arm is too high, the real influence of overweight may be even less marked. This is in striking contrast to the common belief that a definitely positive correlation exists between blood pressure and overweight.

Vogelius and Bechgaard (9), studying the ocular fundi in persons with normal blood pressure, found constricted retinal arteries to be more common in the over-60 age group than in the 40-60 range. A study of the eye ground changes in 500 individuals with hypertension of long duration has been reported by Bechgaard, Porsaa, and Vogelius (1).

Horton's disease in old age has been studied by Greppi (6) and by di Lollo (8). The latter reports a good effect of cortisone and ACTH in low doses.

Eckerström (5) has described a morbid condition which he names phlebitis temporalis subacuta. The clinical picture is characterized by low-grade fever, a debilitated general condition, severe headache, anorexia, insomnia, and the appearance of tender phlebitis in the region of the superficial temporal veins. The symptoms subside within 5-10 weeks. In one case, a biopsy specimen indicated rheumatoid

vascular disease. The author points out the similarity of this condition to temporal arteritis.

Major arteriographic studies involving the upper as well as lower extremities have been published by Donini, Gaia, and Solbiati (4), and Bondani and Donini (2).

REFERENCES


1. Bechgaard, P., Porsaa, K., and Vogelius, H.: Ophthalmological Investigations of 500 Persons with Hypertension of Long Duration. *Brit. J. Ophth., 34:* 409-424, 1950.
2. Bondani, L., and Donini, I.: Rilievi Angiografici sulla Senilizzazione delle Arterie del Piede. *Giorn. Gerontol., 4:* 345-370, 1956.
3. Bøe, J., Hummerfelt, S., and Wedervang, F.: The Blood Pressure in a Population. *Acta med. scandinav., Suppl. 321:* 150-336, 1957.
4. Donini, I., Gaia, C., and Solbiati, G.: Rilievi Anatomo-Radiografici sulle Arterie del Braccio e dell'Avambraccio nelle Varie Epoche della Vita. *Giorn. Gerontol., 5:* 147-165, 1957.
5. Eckerström, S.: Subacute Phlebitis of the Temporal Vessels. *Acta med. scandinav., Suppl. 170:* 169-181, 1946.
6. Greppi, E.: Hortòn Senile. *Giorn. Gerontol., 2:* 657-659, 1954.
7. Hammarström, S., and Bechgaard, P.: Prognosis in Arterial Hypertension *Am. J. Med., 8:* 53-56, 1950.
8. di Lollo, F.: Considerazioni su Due Casi di Arterite Temporale di Horton. *Giorn. Gerontol., 5:* 268-276, 1957.
9. Vogelius, H., and Bechgaard, P.: The Ophthalmoscopical Appearance of the Fundus Oculi in Elderly Persons with Arterio-sclerosis and Normal Blood Pressures. *Brit. J. Ophth., 34:* 404-408, 1950.


HEART DISEASES

The changes which take place in the heart in old age constitute a mixture of pure phenomena of aging (true senile changes) and diseases of old age (atherosclerotic and hypertensive myocardial damage). Strictly clinical studies of the heart are apt, therefore, to lead to erroneous conclusions. Purely senile changes can be assessed only on the basis of postmortem studies.

Geill, in 1951, published a paper on the calcification of the mitral annulus fibrosus (13). On the basis of 230 cases, various clinical, pathologic, and anatomic findings were correlated. It was concluded that calcification of the left annulus fibrosus must be considered a geriatric entity. The disease occurs predominantly in women, the incidence as observed in autopsies of women over 60 years of age being 9.4% as compared with only 2.7% in men above this age. In the age group 80-89 it was present in 12.0% of the women and in 3.2% of the men. The annulus calcification is independent of the existence of a previous mitral endocarditis. The simultaneous occurrence of these two diseases must, therefore, be considered coincidental. Even though the calcification may reach considerable degrees, converting the mitral annulus into a calcified ring, 1 cm. in thickness, it very seldom produces mitral stenosis, and if so only of mild degree. From the annulus, calcified tissue masses may extend into the myocardium, but myocardial complications in the form of conduction disturbances do not develop except in the rare cases in which the interventricular septum is invaded. In approximately two-thirds of the patients with annulus calcification, heart murmurs were demonstrated. Such murmurs were present in only about one-third of the patients without annulus calcification. Heart murmurs associated with annulus calcification were very often diastolic and of a rough character. Since in most instances autopsy did not reveal mitral stenosis, the cause of these murmurs must be sought in the passage of the blood from the left auricle to the left ventricle during the presystolic period, and this causes vibrations of the calcified annulus. Microscopic changes are present in the mitral annulus fibrosus of most aged people (15). The fibrous strands become ever coarser, splitting up as particles of calcium are deposited between them.

In an endeavor to elucidate the purely senile myocardial changes, Geill (14) studied the incidence of brown pigmentation (the so-called brown atrophy) in a large postmortem series (a total of 3,832—2,113 women and 1,719 men) of persons over 60 years of age, the majority ranging from 70 to 90.

The incidence of brown pigmentation proved to increase with advancing age within the total series (tables 1-4). When dividing the material according to sex, however, the incidence of pigmented heart was seen to be practically unchanged throughout old age in men (8.7%—12.0%), whereas among the women there was an even increase from 8.8% at 60-69 years to 25.7% above 90 years of age. The average weight of the pigmented hearts was calculated both for the entire series (493 cases) and for that group (340 cases) which did not exhibit myocardial changes in the form of myofibrosis or infarction. In females as well as in males there was a slight increase in the average cardiac weight with advancing age. In other

TABLE 1. OCCURRENCE OF PIGMENTED HEART. POST MORTEM MATERIAL (3,832 CASES) FROM DE GAMLES BY.

| Age | Total Autopsies | | Pigmented Heart | | | |
|---|---|---|---|---|---|---|
| | Number | | Number | | % | |
| | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ |
| 60 – 69 | 194 | 158 | 17 | 19 | 8.8 | 12.0 |
| 70 – 79 | 846 | 720 | 121 | 73 | 14.3 | 10.1 |
| 80 – 89 | 894 | 732 | 169 | 64 | 18.9 | 8.7 |
| 90 + | 179 | 109 | 46 | 11 | 25.7 | 10.1 |
| | 2113 | 1719 | 353 | 167 | | |
| | 3832 | | 520 | | | |

TABLE 2. AVERAGE WEIGHT (IN GM.) OF PIGMENTED HEARTS.

| Age | Total Series | | Without Myofibrosis | |
|---|---|---|---|---|
| | Number of Cases | Average Weight of Heart | Number of Cases | Average Weight of Heart |
| | Women | | | |
| 60 – 69 | 14 | 280 | 11 | 275 |
| 70 – 79 | 114 | 291 | 89 | 276 |
| 80 – 89 | 161 | 285 | 111 | 282 |
| 90 + | 44 | 292 | 30 | 291 |
| | Men | | | |
| 60 – 69 | 18 | 302 | 10 | 298 |
| 70 – 79 | 72 | 349 | 45 | 349 |
| 80 – 89 | 60 | 331 | 38 | 315 |
| 90 + | 10 | 332 | 6 | 313 |

words, the study did not afford any evidence of essential alteration in the cardiac weight which might account for the increase in the incidence of pigmented heart in women with advancing years. That, nevertheless, the pigmented hearts were relatively small was shown by a comparison of the hearts in Group 2 with a large number of hearts which did not exhibit signs of pigment deposits or of myofibrosis (Group 3). Enlarged hearts (over 350 Gm.) were found in 16.9% of Group 2 as compared with 50.2% of Group 3. To obtain further elucidation of the pigmented hearts, these were correlated to nutritional status, blood pressure, and electrocardiographic findings. A striking proportion of the patients (46.0%) were of a nutritional status below average, 35.5% were average, and 18.5% above average. A normal blood pressure

TABLE 3. WEIGHT OF PIGMENTED HEART.

| Cardiac Weight in Gm. | Total Series (495 cases) | | Without Myofibrosis (338 Cases) | |
|---|---|---|---|---|
| | Number | % | Number | % |
| <200 | 19 | 3.9 | 17 | 5.0 |
| 201–250 | 112 | 74.5 | 88 | 78.1 |
| 251–300 | 148 | | 98 | |
| 301–350 | 109 | | 78 | |
| 351–400 | 69 | 21.6 | 39 | 16.9 |
| 401+ | 38 | | 18 | |

TABLE 4. CARDIAC WEIGHT IN POST MORTEM SERIES (WITHOUT PIGMENTED HEART AND WITHOUT MYOFIBROSIS).

| Cardiac Weight in Gm. | Number of Cases | % |
|---|---|---|
| <200 | 10 | 1.5 |
| 201 – 250 | 43 | 48.3 |
| 251 – 300 | 129 | |
| 301 – 350 | 149 | |
| 351 – 400 | 124 | 50.2 |
| 401 + | 209 | |
| Total | 664 | |

was found in 58.6%, whereas in 24.3% it was slightly elevated, temporarily above 200 mm. Hg in 12.7% and constantly above this level in 4.4%. Normal electrocardiographic tracings were found in 33.7%, left axis deviation in 46.2%, and auricular fibrillation in 10.0%. In the group without fibrosis or infarction, these values were 35.1%, 45.7%, and 8.0%, respectively. Decompensation was found in only a few cases of pigmented heart.

Olbrich, Woodford-Williams, and Webster (22) measured the cardiac output in the aged with sodium fluorescein. They stress that more accurate and basic methods of measurement of cardiac output, by cardiac catheter, cannot be employed in the aged because of the risks involved, the aged being more exposed to complications than the younger age group. Sodium fluorescein has been found to be a useful tool not only in the measurement of cardiac index and pulmonary blood volume, but also when measuring circulation time and general blood volume changes. Vecchi and Saetti (24) determined the circulation time on the basis of calculations according to the Israel-Rendu formula. Casassa, Gobbato, and Meda (6)

studied the heart dynamics in patients ranging in age from 60 to 89. The variations in systole length and in its components (tension time and expulsion time) were compared with the pulse rate; the regression functions of these values were determined. Compared with the conditions in young persons, the heart dynamics were found to change with advancing age. With the increase of the pulse rate, the length of the isotonic systole (expulsion time) was relatively shorter in the old than in the young group. Probably the output is also decreased. The authors suggest that a high pulse rate is inadequate for maintaining a hemodynamic balance in old people. This seems to be indicated by the tendency to bradycardia generally observed in senile patients.

Niemi (20) performed the Master test on subjects in the age range 65-86 years. The two-step exercise test more often showed electrocardiographic changes than the one-step exercise test. It was remarkable that among the patients with an abnormal ECG at rest, several showed normal ECG findings after exertion. Carinci, Abbati, and Petito (5) have also studied the value of Master's test in the aged.

In ballistocardiographic studies Caini (4) found abnormal tracings, indicating incipient coronary disease, in the 40-55-year age range.

Studies on precordial electrocardiograms have been reported by Olbrich and Woodford-Williams (21). In aged subjects with apparently normal hearts they frequently found Q waves in lead $V_3$, and in 11% they observed a depression of the RS-T segment in leads $V_4$ and $V_5$. These authors do not believe in the assumption that the smaller deflections found with advancing years are due to a decrease of the action current of the heart. They attribute the greater variation in amplitude in the aged to the spatial relationship of the heart within the thorax caused by the specific anatomic changes associated with advancing years. According to Fiorio (10), U waves grow more common (15%) with advancing age.

The occurrence of auricular fibrillation in the aged has been reported by Corti and Gallini (7). They succeeded in abolishing this sign in 93% of the patients, invalidating the previous view that auricular fibrillation in the aged is fairly intractable.

Cardiac complications of thyrotoxicosis in old age have been discussed by Eckerström (8) as well as by Iversen (17). The latter author found that 25.5% had auricular fibrillation and 22.0% cardiac insufficiency as compared with 2.0 and 2.6%, respectively, in younger persons.

Mitral disease in patients over 50 years of age has been studied by Trivella (23).

The incidence of myocardial infarction has been studied by Bruzelius (3) in a major series of autopsy records on patients aged over 60. Of these, 20% had infarctions, fresh in 4%. Rupture of the cardiac wall was observed in 0.8%. Infarction of the posterior wall seemed to be just as common, or even more common, than infarctions of the anterior wall. The prognosis was considerably better in cases of acute posterior-wall infarcts than in those of acute anterior-wall infarcts.

Numerous authors have dealt with the clinical aspects of coronary sclerosis and coronary occlusion (Biörck, Overbeck, and Grönvall, 2; Eckerström, 9; From-Hansen, 11; Helander, 16).

Studying the seasonal fluctuations in the mortality from arteriosclerosis as shown by the medical statistics of various countries, From-Hansen (11) found a maximum in the coldest and a minimum in the hottest month of the year, irrespective of whether the country was north or south of the equator. The most marked difference between the mortality in the coldest and hottest month (2: 1) was in England and Portugal. Seasonal variations for cerebral and for cardiac arteriosclerosis were of the same magnitude.

Anderen and associates (1) analyzed the early and late prognosis for patients with myocardial infarction on the basis of the symptoms on admission. The data were derived from hospital records from the County of Copenhagen and were restricted to patients not treated with anticoagulants. The authors worked out a prognostic points system for use in comparing patients treated by different methods.

The value of glutamic acid transaminase determination as a diagnostic method in myocardial infarction has been emphasized by From-Hansen and Laursen (12) as well as by Madsen, Iversen, and Bang (19) and by Linde and Wising (18). The former authors state that the test does not increase the diagnostic or prognostic accuracy in transmural infarc-

tions, but that it is more valuable than the criteria employed hitherto in atypical infarctions, so common in advanced years.

## REFERENCES


1. Andersen, M. S., Bartels, E., Haagensen, N., and From-Hansen, P.: Prognosis in Coronary Thrombosis Not Treated with Anticoagulants. A 10-Year Series. *Second European Congress of Cardiology, Stockholm, 1956. Abstracts*, p. 39-40.
2. Biörck, G., Overbeck, W., and Grönvall, C.: Coronarkrankheit und Herzinfarkt in Malmö. *Cardiologia, 25:* 232-242, 1954.
3. Bruzelius, K.: Lokalisationens Betydning for Hjærteinfarkternes Prognose. *Nord med., 46:* 1231-1232, 1951.
4. Caini, B.: Il Balistocardiogramma negli Anziani e l'Interpretazione Balistocardiografica nella Malattia Aterosclerotica Coronarica. *Giorn. Gerontol., 2:* 55-61, 1954.
5. Carinci, M., Abbati, A., and Petito, S.: La Prova di Master nell'Età Senile. *Giorn. Gerontol., 3:* 559-583, 1955.
6. Casassa, P., Gobbato, F., and Meda, A.: Modificazioni della Dinamica Cardiaca nell'Età Avanzata. *Giorn. Gerontol., 3:* 346-350, 1955.
7. Corti, L., and Gallini, R.: La Fibrillazione Atriale Senile ed il Suo Tratamento. *Giron. Gerontol., 2:* 577-588, 1954.
8. Eckerström, S.: Om Thyreotoxikos, Speciellt hos Äldre Personer. *Svenska läk.sällsk. forhandl., 41:* 1578-1588, 1944.
9. Eckerström, S.: Clinical and Prognostic Aspects of Acute Coronary Occulsion. *Acta med. scandinav., Suppl. 250:* 1-107, 1951.
10. Fiorio, G.: Rilievi Diagnostici Elettrocardiografici sulla Onda U. Particolarmente nell'Età Senile. *Folia cardiol., 14:* 173-187, 1955.
11. From-Hansen, P.: The Mortality by Coronary Thrombosis and Cerebral Haemorrhage by Month in Different Countries. *Third Congress, International Association of Gerontology, London, 1954. Symposia and Abstracts*, p. 123.
12. From-Hansen, P., and Laursen, T.: The SGO-transaminase in Myocardial Infarction. *Danish med. Bull., 4:* 248-251, 1957.
13. Geill, T.: Calcification of the Left Annulus Fibrosis. *J. Gerontol., 6:* 327-333, 1951.
14. Geill, T.: The Senile Heart. *Fourth Congress International Association of Gerontology, Merano, 1957. Abstracts*, p. 142-144.
15. Geill, T., and Kiær, W. Further Investigations of the Age Changes in the Annulus Fibrosus Mitralis. *Acta med. scandinav., Suppl. 266:* 413-417, 1952.
16. Helander, S.: Armchair Treatment of Myocardial Infarction. *Acta med. scandinav., Supp. 308:* 36-37, 1955.
17. Iversen, ...: Thyrotoxicosis in Aged Individuals. *J. Gerontol., 8:* 65-69, 1953.
18. Linde, S., and Wising, P.: Serumtransaminas vid Akut Hjärtinfarkt. *Nord. med., 58:* 1018-1021, 1957.
19. Madsen, S., Iversen, K., and Bang, N.: Serumtransaminase. Et nyt Hjælpemiddel ved Diagnosen af Coronartrombose og Leverlidelser. *Ugesk. laeger., 118:* 599-605, 1956.
20. Niemi, T.: The Master's Two-step Exercise on a Series of 104 "Healthy" Old Individuals. *Third Congress, International Association of Gerontology, London, 1954, Symposia and Abstracts*, p. 193-194.
21. Olbrich, O., and Woodford-Williams, E.: Normal Precordial Electrocardiogram in the Aged. *J. Gerontol., 8:* 40-55, 1953.
22. Olbrich, O., Woodford-Williams, E., and Webster, D.: The Measurement of Cardiac Output in the Aged with Sodium Fluorescein. In: *Old Age in the Modern World*, E. and S. Livingstone Ltd., London, 1955, p. 499-517.
23. Trivella, P.: La Malattia Mitralica nei Soggetti di Età Superiore ai 50 Anni. *Giorn. Gerontol., 1:* 27-54, 1953.
24. Vecchi, G., and Saetti, G.: L'Indice di Rendimento Circolatorio Secondo Israel-Rendu in Individui Sani Oltre i 50 Anni di Età. *Giorn. Gerontol., 2:* 496-509, 1954.


## PULMONARY DISORDERS

Pulmonary diseases in old age have been discussed by Eckerström (5). He states that examination of the respiratory system in old age is not always very informative, especially in the presence of the common senile emphysema of the lungs. The great importance of emphysema in the genesis and course of several respiratory diseases and of its common terminal complication, heart failure, is emphasized. The author also points out the clinical signs of bronchiectasis resulting from chronic bronchitis and draws attention to some characteristics in the course of different forms of pneumonia and their complications, atelectasis, and pulmonary infarcts. Mention is also made of acute pleurisy in cardiac diseases, of tuberculosis and of primary malignancies.

Sartorelli, Ingegnieros, and Martelli (13), studying pulmonary emphysema, state that it is not associated with an increase in the total pulmonary volume, but rather with a reduction (atrophic emphysema). Other studies on senile emphysema have been reported by Barareschi (1), Pasargiklian, Cornia, and Ghiringhelli (11), as well as Sartorelli and Scotti (14). The respiratory function at rest and after exertion in old age has been studied by Ghiringelli and Bosisio (7).

Goudriaan (8) has reported on the treatment of bronchopneumonia in the aged. He divides these cases into two principal varieties (a) primary bronchopneumonia affecting aged

persons in relatively good health, and (b) secondary bronchopneumonia (or "bed pneumonia") affecting bed-ridden persons suffering from a number of different diseases.

Primary tuberculosis in persons of advanced aged has been discussed by Eilertsen (6) who presents Scandinavian values illustrating the age distribution in primary tuberculosis infection and the incidence of negative tuberculin reactions.

Italian investigators have published a number of papers on pulmonary tuberculosis, among them a monograph edited by Daddi, Corda and Pasargiklian (4). Others are by Mars and Ragaini (terminal hemoptysis in the aged, 10) Lucchesi and Somazzi (tuberculosis in psychotic patients, 9), Cafiero and Sprovieri (surgical treatment of pulmonary tuberculosis, 2), and Ragaini and Mandler (tuberculosis of the serous membranes, 12).

## REFERENCES


1. Barbarecchi, G.: Il Polmone Senile. *Giorn. Gerontol., 4:* 103-130, 1956.
2. Cafiero, F., and Sprovieri, L.: Osservazioni sulla Terapia Chirurgica della Tubercolosi Polmonare in Individui Anziani. *Giorn. Gerontol., 2:* 72-75, 1954.
3. Cornia, G., Ghiringhelli, G., and Luna, F.: Caratteristiche Fisiopatologiche dell'Enfisema Polmonare Senile. *Giorn. Gerontol., 4:* 407-410, 1955.
4. Daddi, G., Corda, M., and Pasargiklian, M.: La Tubercolosi nell'Età Avanzata. *Giorn. Gerontol., Suppl. 3:* 1-210, 1954.
5. Eckerström, S.: Respiratory Diseases in Old Age. *Nord. med., 49:* 568-571, 1953.
6. Eilertsen, E.: Primary Tuberculosis in Persons of Advanced Age. *Nord med., 43:* 1480-1483, 1953.
7. Ghiringhelli, G., and Bosisio, E.: La Funzione Respiratoria nell'Età Senile in Condizioni di Reposo e di Lavoro Muscolare. *Giorn. Gerontol., 4:* 477-483, 1956.
8. Goudriaan, J.: The Treatment of Bronchopneumonia in the Aged. In: *Old Age in the Modern World.* E. and S. Livingstone Ltd., London, 1955, pp. 552-555.
9. Lucchesi, M., and Somazzi, D.: Considerazioni sugli Aspetti della Tubercolosi negli Psicopazienti in Età Senile. *Giorn. Gerontol., 2:* 452-460, 1954.
10. Mars, G., and Ragaini, S.: Sulle Emottisi Terminali nella Tubercolosi dell'Età Avanzata. *Giorn. Gerontol., 2:* 661-673, 1954.
11. Pasargiklian, M., Cornia, G., and Ghiringhelli, G.: Incidenza di Enfisema Polmonare Diffuso e Tubercolosi Polmonare in Individui Presenili e Senili. *Giorn. Gerontol., 2:* 558-562, 1954.
12. Ragaini, S., and Mandler, F.: Interessamento delle Sierose nella Tubercolosi Senile. *Giorn. Gerontol., 2:* 24-35, 1954.
13. Sartorelli, E., Ingegnieros, S., and Martelli, G.: Sulla Frequenza e Gravità dell'Enfisema Polmonare Senile. *Giorn. Gerontol., 3:* 129-136, 1955.
14. Sartorelli, E., and Scotti, P.: Rapporti tra Ventilazione Polmonare e Consumo Energetico Durante il Lavoro nell'Età Senile. *Giorn. Gerontol., 5:* 256-260, 1957.


## ANEMIAS

Taglioni and Burlina (5) stress that pernicious anemia occurs predominantly in elderly persons, but that it is often masked by other diseases, particularly of the cardiovascular system. Patrassi (3) has reviewed the various anemias occurring in advanced years. Pernicious anemia is common, and hypochromic anemias caused by hemorrhages and infections are often refractory to treatment. Genuine essential hypochromic anemia is rare.

Pedersen and associates (4) have reported studies of the sternal bone marrow in consecutive cases of histamine-refractory achlorhydria and mild anemia, but without manifest pernicious anemia. All their patients were over 50 years of age. By this method, they diagnosed partial megaloblastic erythropoiesis in 15%. They compare the clinical manifestations with the syndrome of achlorhydria with total megaloblastic erythropoiesis and severe anemia. Both groups are characterized by low iron, $B_{12}$, and vitamin C levels in the blood, especially in women. While the iron and C deficiency seems to be equally pronounced in both groups, the $B_{12}$ deficiency was, as might be expected, least marked in patients with partial megaloblastic erythropoiesis. Achlorhydriacs with partial megaloblastic erythropoiesis seem to fall into two clinical types, one bearing the marks of incipient pernicious anemia complicated with iron and vitamin C deficiency, whereas the other type is characterized by anemia of a different pathogenesis, usually chronic nephrogenous hemolytic anemia, complicated intermittently by toxic-infectious anemia caused by drug intoxication and coli bacteriemia. Examination of the sternal bone marrow is the most important method for diagnosing partial megaloblastic erythropoiesis. Determination of the $B_{12}$ level in the blood will probably acquire significance, and it is important to know that mild $B_{12}$ deficiency anemia is common, usually complicated by iron deficiency and other forms of anemia. It may be profitable to repeat the test after massive iron mediaction. Treatment with vitamin $B_{12}$, iron, and

vitamin C is efficient, but has to be intensive. This applies particularly to iron, which at the outset often has to be administered intravenously. Even in uncomplicated cases, normal blood values are frequently not attained until after 6 months' treatment. Iron deficiency in patients with megaloblastic erythropoiesis is probably not due exclusively to a reduced power of absorption, but also to insufficient nutrition. This is indicated by the pronounced vitamin C deficiency which yields to oral administration of vitamin C. It is assumed that elderly women with achlorhydria are particularly exposed to erroneous nutrition.

According to Eckerström (2), sideropenic anemia in elderly people is often associated with ulcers of the leg. Effective iron medication may cure the anemia as well as the ulcerations. Berselli and Rizzente (1) have obtained good results by treating hypochromic anemia in elderly cancer patients with intravenous iron and amino acids.

REFERENCES

1. Berselli, L., and Rizzente, S.: Sulla Terapia Marziale delle Anemie Ipocromiche nei Cancerosi Gastrici in Età Senile. *Giorn. Gerontol., 5:* 173-175, 1957.
2. Eckerström, S.: Recherches sur le Fer du Sérum chez les Vieillards, Spécialement par Rapport aux Ulcérs Chroniques des Jambes. *Acta med. scandinav., 118:* 69-78, 1944.
3. Patrassi, G.: Anemie nei Vecchi e Anemie dei Vecchi. *Giorn. Gerontol., 2:* 481-495, 1954.
4. Pedersen, J., Lund, J., Søeborg-Ohlsen, A., and Østergaard-Kristensen, H.: Partial Megaloblastic Erythropoiesis in Elderly Achlorhydric Patients with Mild Anemia. *Lancet, 272:* 448-453, 1957.
5. Taglioni, V., and Burlina, A.: Su Alcuni Aspetti Clinici della Anemia Perniciosa nell'Età Senile. *Giorn. Gerontol., 4:* 411-418, 1956.

DISEASES OF THE LIVER

Cirrhosis of the liver is fairly common in old age. Among 3,177 autopsies on persons over 61 years of age, Bock (1) found hepatic cirrhosis of the Laennec type in 4.3%, mostly women. According to Geill (3), another postmortem series from the same geriatric department (De Gamles By, Copenhagen) showed hepatic cirrhosis, predominantly of the portal variety, in 6.1%. Abuse of alcohol had been present in only a few of the cases, but in some instances the possibility of sequelae of latent viral hepatitis could not be ruled out. As a result, both Bock and Geill are inclined to interpret the common occurrence of cirrhosis in old age as liver damage of still unknown nature. Geill pointed out that the intestinal canal of elderly people, especially those with achlorhydria, contains large quantities of putrefactive bacteria, and that the hepatic damage in old age might be imagined to be caused by a kind of autointoxication. It is well known that in chronic colitis complicating liver disease is common (first fatty degeneration and later cirrhosis). Diverticulitis, which is common in old age, may possibly also entail hepatic complications.

Leonardi (4) has reported a study on aspiration biopsies from the livers of 50 subjects aged 60-79. In 16 apparently normal persons there was a moderate amount of pigment in the liver cells, slight scattered fibrosis, congestion of the hepatic veins, and mild arteriosclerotic changes. The content of glycogen, alkaline phosphatase, and iron was normal. Leonardi suggests that the so-called benign "cirrhosis in the aged" is merely focal liver sclerosis of different origin. In such cases, repeated liver damages in the course of many years have made the sclerosis generalized and very similar to true liver cirrhosis.

De Grailly and Destrem (2) conducted thorough studies of the liver in 100 aged patients. The bleeding time and clotting time were normal in men and nearly always prolonged in women. Galactose tolerance tests revealed abnormal galactosuria in 60% of the men and in 100% of the women. Elimination of hippuric acid was reduced in 43% of the men and in 85% of the women. Liver function tests with dyes revealed abnormalities in from 50-66%. Histologic examination of the liver from 16 patients who had been submitted to liver function tests *in vivo* indicated pronounced deficiency of glycogen in the liver cells. This was practically a constant finding in cases where the galactose test had been positive. In another 2 patients they found a characteristic histologic appearance consisting in obliteration of the capillaries and disseminated atherosclerosis; correspondingly, there was parenchymal degeneration of the hepatic tissue proportional to the degree of the ischemic lesion. Thus, in general, the liver seems to be defective in old age.

REFERENCES

1. Bock, J.: Liver Cirrhosis in the Aged. *J. Gerontol.,* 3: 111-118, 1948.

2. De Grailly, R., and Destrem, H.: Les Transformations du Foie Senile. *Third Congress, International Association of Gerontology, London, 1954. Symposia and Abstracts,* pp. 118-119.
3. Geill, T.: Studies on Blood Coagulation in Old Age. Pulmonary Thrombosis and Embolism in Cirrhosis of the Liver. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 267-269.
4. Leonardi, P.: Reperti Epatobioptici nella Senescenza. *Giorn. Gerontol., 5:* 139-146, 1957.

## DIABETES MELLITUS

Schmidt (4) has studied diabetes mellitus in elderly people. Among 108 cases he found 25 exhibiting recovery or regression. Schmidt discussed the factors influencing the carbohydrate metabolism with special emphasis on the thyroid and pituitary glands.

Lundbæk (2) has reported a follow-up study on all diabetics in the city of Århus, Denmark (population 165,000). In the group over 50 years of age 61% of the men and 88% of the women had hypertension. Chronic nephropathy was present in 25% of the surviving patients and was somewhat more common in the older age groups. Heart disease was observed in 40% of the surviving patients and had been present in a higher percentage of the deceased patients. About 80% had retinopathy which was unrelated to sex, blood pressure, and age; 3% of the survivors were blind. Vascular disturbances affecting the lower limbs (absent or reduced pulsation in the dorsal artery of the foot, intermittent claudication, gangrene) were found in 49% of the over-60 group as compared with 28% of the entire series.

Other studies have been published by Malizia and Scapellato (3), Torresini (6), and Santagati and Gattini (4). The last-mentioned authors presented a statistical study on the onset and average duration of diabetes mellitus in 1500 patients at the Antidiabetic Center, Medical Clinic, University of Rome. Most commonly the disease set in between 50 and 60 years of age, and the average duration was 7 years 9 months. In 15 patients with senile diabetes, some of whom had already received small doses of insulin, Andreani (1) obtained good results with the new oral preparations.

## REFERENCES

1. Andreani, G.: Il Trattamento Ambulatorio del Diabete Senile con gli Ipoglicemizzanti per Via Orale. *Giorn. Gerontol., 5:* 416-417, 1957.
2. Lundbæk, K.: Late Diabetes, Incidence of Late Diabetic Manifestations in Regional Case Material. *Acta med. scandinav., Supp. 277:* 143-146, 1953.
3. Malizia, E., and Scapellato, L.: Osservazioni sul Diabete Senile. *Giorn. Gerontol., 1:* 418-423, 1953.
4. Santagati, U., and Gattini, M.: Considerazioni sull'Età di Insorgenza Apparente e sulla Durata Media del Diabete. *Giron. Gerontol., 1:* 240-247, 1953.
5. Schmidt, V.: The Course of Diabetes Mellitus During Old Age. *Acta med. scandinav., 116:* 340-356, 1944.
6. Torresini, A.: Centri Geriatrici ed Attività Antidiabetica. *Giorn. Gerontol., 1:* 248-251, 1953.

## HORMONAL DISORDERS

Iversen (10) has analyzed all cases of thyrotoxicosis admitted to the municipal hospitals in Copenhagen during a 7-year period. The percentage of patients above 60 years of age was 9.8. Compared with the younger group, the elderly patients had had their disease for longer before admission, their basal metabolic rates were usually higher, and they had sustained a greater weight loss. Comparison of the symptoms and signs in the patients above 60 with those below 60 showed a more oligosymptomatic form of the disease in the over-60 group. Typical findings in the aged patients were an absence of exophthalmos and other eye symptoms, a nodular form of goiter, or even absence of palpable enlargement of the thyroid. The most marked differences were seen in the cardiovascular disturbances. Auricular fibrillation and cardiac insufficiency occurred in 25.5% and 22.0% of the older group against 2.0% and 2.6% in the younger.

Among other authors, there is Della Beffa (4), who points out that the clinical and metabolic characteristics differentiate hyperthyroidism in old from that in young and middle-aged individuals. Busnengo, di Girolamo, and Pecora (3) report that protein-bound iodine is less elevated in old than in young men after treatment and the metabolic rate is higher in young than in old men.

Grytting (9) thinks that the extensive medication with iodine-containing drugs for arteriosclerosis and hypertension may be partially responsible for the increasing incidence of thyrotoxicosis in elderly patients. He does not want to exclude psychosomatic causes, however, and points out the predominance of cardiovascular symptoms and the decrease in classic vegetative symptoms. This author concludes that every case of heart failure with tachycardia and pos-

sibly auricular fibrillation of uncertain etiology ought to be examined for thyrotoxicosis.

In monographic form, Antognetti and Scopinaro (1) have described the function of the endocrine glands in old age.

Pende (16) states that, before Bogomoletz, he demonstrated that the mesenchymal tissue, combined with some endocrine changes, is responsible for all essential and for premature senile changes. He sets up four gerotypes or biotypes of the senescent man, viz. 1) the Cushingoid hypertonic, 2) the thyrotoxic irritable, 3) the asthenic cachectic, and 4) the eunuchoid or intersexual.

Friedberg (6) found the adrenocortical response to ACTH to be equally marked in elderly and in young persons, although there was some indication that old and young individuals responded in qualitatively different ways.

In Morgagni's syndrome there is, according to Schmidt (17), no relationship between hyperostoses and symptoms from the central nervous system. On the other hand, hypertension, cholelithiasis, osteoarthritis, and hemiparesis are common. This is related by the author to obesity.

Warter, Schwartz and Weryha (19) report that aged persons suffer from adrenal cortical insufficiency, which is, however, neither constant nor total.

di Girolamo, de Pedrini, and Patrono (8) have studied the urinary excretion of freely soluble ketosteroids (11-oxycorticoids) and slightly soluble ketosteroids. Between the ages of 30 and 70, the ratio decreases, reaching values almost like those seen in infancy. Between 70 and 80 years, there is again an increase.

Magliocca and Natoli (11), Frassineti and Vallecorsi (5) and Vallecorsi and Frassineti (18) have determined the urinary excretion of 17-ketosteroids and gonadotrophin. Urinary neutral 17-ketosteroids were found to be reduced in a group of people over 80 years of age, more so in men than in women. In men, the urinary gonadotrophin was increased in 25%, normal in 53.5%, and reduced in 21.5%. In women, these values were 71.8%, 20.5%, and 7.7%, respectively. Urinary excretion of 17-ketosteroids following administration of testosterone has been studied by di Girolamo and Nicolosi (8), Natoli and Nicolosi (12), and Pecora and Natoli (14). After intravenous injection of 50 mg. testosterone sodium sulphate, the urinary 17-ketosteroids showed a much more marked and more constant increase in young than in old subjects, while the latter exhibited a more marked increase of plasma 17-ketosteroids than the former. Administration of testosterone is not followed by an increase in the urinary exretion of androsterone as in young subjects.

Arata, Girolamo, Misiti, and Zenobi (2) have reported long-term treatment with testosterone, methyl androstenediol, and anterior pituitary extract without finding any effect on geriatric diseases. Only testosterone had some symptomatic effect on the cenesthesia and muscular strength of the old subjects.

Patrono and di Girolamo (13) published a comprehensive monograph, in Italian with an English summary, on the use of hormones in the treatment of geriatric diseases.

## REFERENCES


1. Antoggnetti, L., and Scopinaro, D.: Rapporti tra Glandole Endocrine e Vecchiaia. *Giorn. Gerontol., Suppl. 2:* 1-227, 1954
2. Arta, L., di Girolamo, L., Misiti, R., and Zenobi, M.: Effetti della Somministrazione Prolungata di Testosterone, Metilandrostendiolo e di Estratti Preipofisari nel Vecchi. *Giorn. Gerontol., 5:* 418-421, 1957.
3. Busnengo, E., di Girolamo, L., and Pecora, P.: Effetti e Metabolismo dei Tireoidi nei Vecchi. *Giorn. Gerontol., 5:* 432-434, 1957.
4. Della Beffa, A.: L'Ipertiroidismo nella Vecchiaia. *Giorn. Gerontol., 2:* 162 -171, 1954.
5. Frassineti, A., and Vallecorsi, G.: Considerazioni Clinico-ormonali sul Climaterio Maschile. *Giorn. Gerontol., 2:* 172-175, 1954.
6. Friedberg, R.: ACTH Administration, Adrenal Response, and Age. *J. Gerontol., 9:* 429-438, 1954.
7. di Girolamo, L., and Nicolosi, G.: Richerche sul Metabolismo del Testosterone nei Vecchi. *Giorn. Gerontol., 5:* 435-437, 1957.
8. di Girolamo, L., de Pedrini, P., and Patrono, V.: La Eliminazione Urinaria di Steroidi Chetonici. A. Fosfomolibdico-riducenti (Frazione Poco e Frazioni Bene Solubile in Acqua) Durante l'Età della Vita Comprese fra 30 e 80 Anni. *Giorn. Gerontol., 2:* 431-441, 1954.
9. Grytting, G.: Thyreotoxikose hos Eldre, Særlig med Henblik på Thyreotoxisk Krise. *Nord. med., 50:* 1159-1161, 1953.
10. Iversen, K.: Thyrotoxicosis in Aged Individuals. *J. Gerontol., 8:* 65-69, 1953.
11. Magliocca, R., and Natoli, A.: L'Eliminazione Urinaria dei 17-chetosteroidi e del Deidroisoandrosterone negli Individui Normali di Ambo i Sessi in Età Comprese tra i 50 e gli 80 Anni. *Giorn. Gerontol., 2:* 550-557, 1954.

12. Natoli, A., and Nicolosi, G.: Comportamento dei 17-chetosteroidi Ematici ed Urinari dopo Somministrazione Endovenosa di Testosterone nei Vecchi. *Giorn. Gerontol., 5:* 438-443, 1957.
13. Patrono, V., and di Girolamo, L.: Gli Hormoni nella Terapia Geriatrici. *Giorn. Gerontol., Suppl. 12:* 1-203, 1956.
14. Pecora, P., and Natoli, A.: Studio Cromatografico dei 17-chetosteroidi Urinari dopo Carico "Acuto" di Testosterone nei Vecchi. *Giorn. Gerontol., 5:* 441-443, 1957.
15. Pecora, P., and Natoli, A.: Studio Cromatografico dei 17-chetosteroidi Urinari dopo Somministrazione Prolungata di Testosterone nei Vecchi. *Giorn. Gerontol., 5:* 444-446, 1957.
16. Pende, N.: L'Insuffisance du Mésenchyme et des Hormones Mésenchymotropes dans la Sénèscence. *Giorn. Gerontol., 2:* 703-708, 1954.
17. Schmidt, V.: Hyperostosis Frontalis Interna og Morgagnis Syndrom. *Ugesk. laeger, 106:* 1064-1067, 1944.
18. Vallecorsi, G., and Frassineti, A.: Relievi Clinico Ormonali in Soggetti Anziani. *Giorn. Gerontol., 2:* 176-181, 1954.
19. Warter, J., Schwartz, J., and Weryha, A.: La Fonction Cortico-surrénale chez le Vieillard. *Giorn. Gerontol., 4:* 391-396, 1956.

## DISORDERS OF THE CENTRAL NERVOUS SYSTEM

Extensive studies on the age changes in the central nervous system were carried out by Bürger (2); 250 human brains, 225 spinal cords, and 236 sciatic nerves were examined. After the age of 40 years the weight of the brain is diminished, both in dry substance and water content. The ash content was found reduced with age, but in the last decades the calcium values increased, apparently on account of the atherosclerosis in the brain arteries. Although the total lipids in brain and spinal cord did not show significant alterations in old age, the lipid content of the sciatic nerve was found to increase from 50 to 70%. In Bürger's opinion the age changes in the central nervous system are only an expression of the normal tissue changes, which take place through the whole life of man (biomorphosis). Further description of the age changes in the human brain was given by Hoff and Seitelberger (7). Sjögren and associates (11) studied morbus Alzheimer and morbus Pick.

Dalsgaard-Nielsen (4) surveyed 1000 cases of cerebral vascular accidents. The percentage distribution according to occupational groups was as follows:

| | Men | Women | Total |
|---|---|---|---|
| Brain Workers | 27.0 | 6.2 | 14.7 |
| Manual Workers | 53.4 | 6.1 | 25.4 |
| Housewives | — | 79.7 | — |
| Others | 19.6 | 8.0 | 12.7 |

The great majority of the apoplexies occurred in the ages of 60-79 years, the average age for men and women being nearly the same, about 70 years. The number of emboli was 7%, of thromboses 50%, and of hemorrhages 43%. The mortality rate was 44.3%, 44.6% among men and 44.1% among women. The postmorbid status showed 19% helpless, 47% heavily disabled, 23% moderately disabled, 11% slightly disabled, and less than 1% not disabled. Chandler and associates (3) treated 46 of 86 patients suffering from apoplexia cerebri with cortisone, but found no significant effect compared with the controls.

Orma and Koskenoja (9) studied dizziness in the aged. Postural dizziness was found to be the typical form of dizziness in the aged. Its etiology was investigated by comparing a group without dizziness. It was ascertained that cerebral neurologic symptoms, headache, tinnitus, cardiac failure, high blood sugar values, and positional nystagmus were significantly more frequent in the postural dizziness group. No other difference was observed between the groups in any aspect of internal medicine, neurology, otology, or ophthalmology. The same authors (10) also studied the continuous dizziness. Most of the patients of this group were in poor physical condition. Many had severe ataxia and tremors and poor psychic activity. Apparently such continuous dizziness occurs in patients with extensive diffuse brain lesions, either degenerative or arteriosclerotic. Orma (8) reported that hydrogenated ergot alkaloids had a significant favorable effect on postural dizziness. This effect seemed to be the result of improved cerebral blood flow and the sedative property of the drug.

Stimulation therapy for mental disorders in aged patients was used by Dymling and Eckerström (5). The latter (6) published later a more extensive study; 67 agitated, confused, or apathic elderly patients received a preparation (Sevanil) consisting of vanillic acid, diethyla-

mide, and nicotinic acid in order to improve cerebral circulation. Results of the treatment were particularly good among the agitated and disturbed patients. The best effect was found in patients with symptoms of cerebral arteriosclerosis and signs of vascular lesions and also in patients with senile and arteriosclerotic dementia, in which cases such symptoms as urinary and fecal incontinence disappeared during treatment.

Aslan (1) used novocain in the treatment of aging. The technique consisted in prolonged and discontinuous treatment usually by intramuscular shots. Eutrophic and rejuvenating effects were demonstrated by clinical physiologic, biochemical, and hematologic criteria, and by low mortality rate; 4900 patients were treated. The action of novocain on the nervous system as well as its biocatalyzing effect were emphasized.


REFERENCES

1. Aslan, A.: Researches on the Action of Novocain (Substance $H_3$) as an Eutrophic and Rejuvenating Factor. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries*, pp. 67-68.
2. Bürger, M.: Das Altern des Zentralnervensystems. In: *Experimentelle Alternsforschung*, F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 101-111.
3. Chandler, G., Clark, A., Higgins, F., Newcombe, C., and Travener, D.: Cortisone in the Immediate Treatment of Cerebral Apoplexy. *Giorn. Gerontol., 5:* 717-722, 1957.
4. Dalsgaard-Nielsen, T.: Survey of 1000 Cases of Apoplexia Cerebri. *Acta psychiat. et neurol. scandinav., 30:* 169-185, 1955.
5. Dymling, A., and Eckerström, S.: Stimulation Therapy for Mental Disorders in Aged Patients. *Geriatrics 11:* 453-455, 1956.
6. Eckerström, S.: Erfahrungen mit der Stimulationstherapie bei psychischen Krankheitszuständen des Seniums. *Fourth Congress, International Association of Gerontolgy, Merano, 1957, Summaries*, p. 129.
7. Hoff, H., and Seitelberger, F.: Das alternde Gehirn. In: *Alter und Krankheit*, W. Doberauer, ed. Verlag "Gesellschaft zur Förderung wissenschaftlicher Forschung." Vienna, 1957, pp. 43-58.
8. Orma E.: Hydrogenated Ergot Alkaloids (Hydergine) in the Treatment of Geriatric Postural Dizziness. *Ann. med. int. Fenniae, 45:* 39-44, 1956.
9. Orma, E., and Koskenoja, M.: Postural Dizziness in the Aged. *Geriatrics, 12:* 49-59, 1957.
10. Orma, E., and Koskenoja, M.: Dizziness Attacks and Continuous Dizziness in the Aged. *Geriatrics, 12:* 92-100, 1957.
11. Sjögren, T., Sjögren, H., and Lindgren, A.: *Morbus Alzheimer und morbus Pick.* E. Munksgaard, Copenhagen, 1952, pp. 1-152.


## DISEASES OF THE SKIN

Manganotti (3, 4) published an extensive monograph concerning age changes in the human skin. Agostini (1) described angiodermatitis and Caccialanza (2) tuberculosis in the skin. Mattei, Cognasso, and Torazza-Gazzera (5) reported that the content of calcium in the fingernails augments with age.


REFERENCES

1. Agostini, A.: Contributo alla Conoscenza di Alcuni Più Comuni Tipi di Angiodermiti della Gamba. *Giorn. Gerontol., 3:* 351-377, 1955.
2. Caccialanza, P.: Osservazioni sulla Tubercolosi Cutanea nell'Età Senile. *Giorn. Gerontol., 2:* 337-345, 1954.
3. Manganotti, G.: Rilievi Generali e Considerazioni sulla Cute Senile. *Giorn. Gerontol., Suppl. 5:* 9-127, 1955.
4. Manganotti, G.: Contributo all Studio dei Fenomeni di Senescenza della Cute Umana. *Giorn. Gerontol., Suppl. 7:* 43-54, 1955.
5. Mattei, C., Cognasso, P., and Torazza-Gazzera, M.: Sul Contenuto in Calcio delle Unghie nelle Varie Età del'Uomo. *Giorn. Gerontol., 3:* 511-517, 1955.


## NUTRITION AND VITAMINS

During recent years, keen interest has been displayed in the nutrition of the aged. Vinther-Paulsen (7, 8, 10) called attention to the fact that quite a large group of elderly persons, particularly women, show signs of undernutrition caused by too small a food intake. Most of these persons are suffering from advanced cerebral arteriosclerosis and dementia. Vinther-Paulsen called the condition primary senile anorexia. Dietetic calculations revealed that the daily intake of food amounted to only 500-1200 calories. The patients were greatly emaciated and exhibited signs of glossitis, first a swollen, red, and later a smooth tongue. They complained of burning of the tongue, especially after eating sour and spicy foods (fig. 4). Their pale skin was in marked contrast to the bluish red lips, and they had fissures at the corners of the mouth. This group of patients often had anemia of the hypochromic type, hypoproteinemia, osteoporosis, especially of the spine, and various hypo- and avitaminoses, predominantly ariboflavinosis and p e l l a g r a. Calculations showed a dietetic deficit of protein, calcium, phosphorus, iron, and a number of vitamins

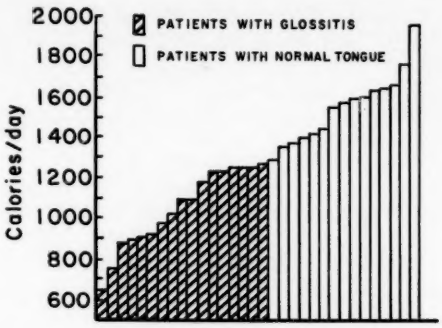


Fig. 4. Caloric Intake in Normal Old People and in Patients with Senile Anorexia (after Vinther-Paulsen, 10).

(A, $B_1$, $B_2$, niacin, C, and D) (fig. 5). Vinther-Paulsen (9) stated that since the food requirement of older individuals is hardly much lower than that of younger adults, particular attention should be paid to the nutrition of elderly hospitalized patients. The importance of supplying an adequate milk intake is emphasized.

Valuable contributions have been published by Italian workers: Alessandrini (1), Bertarelli (2), and by Coppo and Bonati (3) (monograph on vitamins and old age, 4).

Nordlander (5) has stressed the correct proportions of amino acids and the role of unsaturated fats as well as the necessity of detecting defects in absorption in patients with achlorhydria and sequelae of gastric resection.

According to Schulze (6), the protein need in the aged is lowered, but it cannot be decided whether this represents the real requirements. A large number of factors must be taken into account, such as habits, social status, and the tendency to limit the food intake in order to prevent obesity. A daily intake of 1.0 to 1.5 Gm. protein per Kg. body weight in a mixed diet supplying 2000-2200 calories per day is said to be ideal for an elderly person weighing 60 Kg.

## REFERENCES

1. Alessandrini, P.: Alimentzaione e Vecchiaia. *Giorn. Gerontol., 1:* 150-170, 1953.
2. Bertarelli, E.: Il Latte e l'Alimentazione del Vecchio. *Giorn. Gerontol., 1:* 271-277, 1953.
3. Coppo, M., and Bonati, B.: Vitamine e Senescenza. *Giorn. Gerontol., 5:* 337-341, 1957.
4. Coppo, M., and Bonati, B.: Vitamine e Seneseenza. *Giorn. Gerontol., Suppl. 11:* 1-160, 1957.
5. Nordlander, N. B.: Näringsfrågor inom Geriatriken. *Nord. med., 57:* 453-457, 1956.
6. Schulze, W.: Der Eiweisstoffwechsel und Proteinbedarf des Älteren Menschen. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 201-201.
7. Vinther-Paulsen, N.: Glossitis as Indicator of Nutritional Deficiency in the Aged. *Rev. méd. Liège, 5:* 652-654, 1950.
8. Vinther-Paulsen, N.: Glossitis and Epithelial Atrophy in Old Age. *Rev. Vitamin Res., 24:* 148-154, 1952.
9. Vinther-Paulsen, N.: Investigations of the Actual Food Intake of Elderly Chronically Hospitalized Patients. *J. Gerontol., 5:* 331-338, 1950.
10. Vinther-Paulsen, N.: Senile Anorexia. *Geriatrics 7:* 274-279, 1952.

## INTESTINAL FLORA

The intestinal flora in old people was studied by Orla-Jensen, Olsen, and Geill (1, 2), and a reexamination of Metchnikoff's hypothesis carried out. Since Yoghurt bacteria grow but poorly in the animal and human colon, they are not suited for the purpose of suppressing the putrefactive processes arising in the colon. If the colon in certain diseases is in need of a change of its bacterial flora, this change should be produced by means of milk cultures of the lactic acid bacteria characteristic of the normal

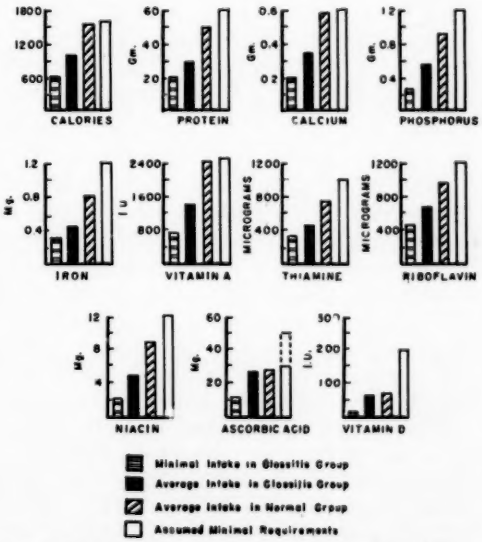


Fig. 5. Average Intake of Various Nutrients in Normal Old People and in Old People with Senile Anorexia. The dotted line in the figure on ascorbic acid refers to the minimum daily intake recommended by American authorities (after Vinther-Paulsen, 10).

colon, viz., *Bacterium bifidum* and *Thermobacterium intestinale*. Normally these bacteria (especially the former) are present in ample amounts in the human colon. If they do not develop and form acid it is because insufficient sugar is provided with the food. Some putrefaction in the last part of the colon and in the rectum cannot be avoided, but with a sensible diet there is extremely slight danger of the putrefactive processes in the colon gaining the upper hand, as long as the hydrochloric acid production of the stomach is at its full height. This arrangement by which more of the harmful bacteria in the food are destroyed is frequently apt to fail, however, with advancing age. For this reason, feces from old people show on the average more putrefactive bacteria and less *Bact. bifidum* than feces from young and healthy people (table 5). When the acid production failed there was also a greater chance for the salivary streptococci, *Streptococcus salivarius*, to pass unscathed through the stomach. Persons with pH in a test meal lying between 1.6 and 2 (normochlorhydria) had numerous *Bact. bifidum* in feces. Persons with pH in a test meal lying between 2 and 5 (hypochlorhydria) had a large number of both *Bact. bifidum* and *Str. salivarius* in feces, and persons with pH in a test meal lying between 5 and 7 (achlorhydria) had a large number of *Str. salivarius* in feces. The reason that the putrefactive processes in the colon increase when the hydrochloric acid production in the stomach diminishes is not only to be found in the poorer digestion of the proteins but also in the circumstances that the food, instead of being almost sterile when it leaves the stomach, is so filled with bacteria that the carbohydrates, are already fermented in the small intestine. The last mentioned condition seems to be improved if only a little amount of hydrochloric acid (2-4 tablets of betaine-hydrochloride, each 0.25 Gm.) is consumed in connection with the chief meals.

TABLE 5. INTESTINAL FLORA (2, P. 10).

| Persons under Observation | Percentage of Persons Having in Their Feces (per Gm.) More Than | | | |
|---|---|---|---|---|
| | 100,000,000 *Str. salivarius* | 1,000,000,000 *Bact. bifidum* | 100,000,000 *Bact. bifidum* | 100,000,000 *Clostridia* |
| Young (30–40 years)..... | 0 | 57 | 100 | 0 |
| Old, nonsenile (above 70 years)..... | 31 | 25 | 44 | 9 |
| Old, senile (above 70 years)..... | 35 | 7 | 9 | 48 |

## REFERENCES


1. Orla-Jensen, S., Olsen, E., and Geill, T.: Senility and Intestinal Flora, a Reexamination of Metchnikoff's Hypothesis. *Kgl. Danske Videnskab. Selskab. Biol. Skrifter, 3:* 1-38, 1945.
2. Orla-Jensen, S., Olsen, E., and Geill, T.: Senility and Intestinal Flora. *J. Gerontol., 4:* 5-15, 1949


## AUTOINTOXICATION

The idea that intestinal putrefaction in the human colon might entail autointoxication was advanced toward the end of the 18th century (Baumann, 1), and it was elaborated by Metchnikoff (6). Studies on the intestinal flora have been carried out by Orla-Jensen, Olsen, and Geill (9) who found the putrefactive bacteria in the colon to be far more predominant in persons over 70 years of age than in people in the 30-40 year age range. Among the older group, those who were senile exhibited the largest number of putrefactive bacteria in the bowel. These authors did not, however, draw any conclusion regarding a possible correlation between intestinal putrefaction and senile changes, especially atherosclerosis.

During recent years, Korenchevsky (4) has particularly devoted himself to the hypothesis that changes of aging represent autointoxication. At the symposium for experimental research on aging in Basel, 1956, one of the sessions was reserved for autointoxication. Korenchevsky (4), reviewing the various forms of autointoxication, concluded that the most probable theory of old age seems to be the "self-destruction theory." In his opinion, it explained "physiological aging, physiological span of life, physiological death, and their fixed characteristics in each species by the inherent deficient nature of physico-chemical structure and of the endogenous processes of the organism." He stated that the theory was supported by the toxic properties of some proteinic metabolites and certain hormones normally present in the blood and tissues of the organism. In relation to Korenchevsky's paper, Fischer (2) discussed the toxic effect of certain amino acids in experiments on the rat.

Olbrich and Woodford-Williams (7) submitted comprehensive studies on the measurement of total body water and extracellular water in absolute quantities in the aged and aging. Seventy-one male subjects were investigated between the ages of 45 and 93 years. Among these, 43 were normal, 14 were dehydrated (6 with intracellular and 8 with extracellular fluid loss). Overhydration was found in another 14 cases (11 with excessive extracellular and 3 with excessive intracellular fluid). The decrease of intracellular water associated with decreasing cell solids and the constant or increasing extracellular water, with fat mass varying, they considered a true sign of aging. In another series (8), the same authors investigated the possibility of testing methods of elimination of protein waste products from the blood and tissues of old people. They conclude that nitrogen retention occurs when saline is given intravenously. Forcing water has no specific effect on nitrogen elimination. The saline administration disturbs the blood chemistry by causing general retention of water and of blood solutes, an effect which may be extremely hazardous, especially in the aged.

Huet (3) pointed out that autointoxication and dehydration were concomitant in elderly persons. The electrolyte equilibrium and the osmotic pressure indicate the degree of the named conditions. In his opinion, the degree of polypeptidemia and the erythrocyte sedimentation rate are two fairly accurate routine tests which are applicable in practice.

REFERENCES


1. Baumann, E.: Die aromatischen Verbindungen im Harn und die Darmfäulniss. *Ztschr. f. physiol. Chem. 10:* 123-133, 1886.
2. Fischer, R.: Possible Toxis Effect of Amino Acids in Normal Diets. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 225-235.
3. Huet, J.: La Polypeptidémie et la Vitesse de Sédimentation dans les Troubles du Métabolisme de l'Eau au Cours de l'Auto-intoxication des Vieillards, In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 253-255.
4. Korenchevsky, V.: Autointoxications and Processes of Ageing. *Texas Rep. Biol. & Med., 12:* 1006-1036, 1954.
5. Korenchevsky, V.: Problem of Autointoxication in Gerontology. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 216-224.
6. Metchnikoff, E.: Etudes sur la Flore Intestinale. *Ann. Inst. Pasteur., 22:* 929-955, 1908.
7. Olbrich, O., and Woodford-Williams, E.: Water Distribution in the Aged in Correlation to Cardiac and Renal Function. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 236-245.
8. Olbrich, O., and Woodford-Williams, E.: The Influence of Normal Saline Injections and Water Ingestion on the Excretion of Nitrogenous End Products in Old People. In: *Experimentelle Alternsforschung,* F. Verzár, ed. Birkhäuser Verlag, Basel-Stuttgart, 1956, pp. 246-252.
9. Orla-Jensen, S., Olsen, E., and Geill, T.: Senility and Intestinal Flora. *J. Gerontol., 4:* 5-15, 1949.


SURGERY

The enormous advances of the past few decades within surgery and anesthesiology have greatly improved the prognostic outlook for aged persons with operative disorders. At the same time, they have aroused the interest of surgeons in surgical geriatrics as witnessed by numerous recent publications.

Wulff, Lindskog, and Merits (15) have reported the results from Malmö, Sweden, for the period 1941-1950. The total operative mortality among patients over 65 was 11.5%. In operations on the biliary tract the mortality fell from 10.0% to 4.8%. While in 1941 only 20% of the cancer patients were operable, this percentage had risen to about 50 in 1950. The authors ascribe the decreasing mortality to improved anesthetic service and more effective postoperative management. Among postoperative complications 60% were from the lungs, 20% from the cardio-vascular system, and 20% from other organs. A monograph on the surgical treatment of the aged has been published by Malan and associates (9). According to Brotherus (1), appendicitis is remarkably less common in old than in young perons, and in old patients it is more apt to take on a destructive character.

In a large mixed operative series Moritsch (11) found the mortality after emergency operations to be about 30% and after elective operations only 14%. The most common causes of death were peritonitis following laparotomies, and pulmonary emboli. In another publication (12), Moritsch has reported that in cases of circulatory disturbances in the limbs 29% had to have amputations for gangrene. Out of the operated cases about 30% died, most of them with severe arteriosclerosis, pneumonia, and pulmonary embolism. Accord-

ing to Doberauer (3), elderly patients are no poorer surgical risks for operations on the sympathetic nervous system than young people. He gives a major survey of such operations which can relieve old people of pain and inconvenience. Neurogenic appendicopathy, neurogenic cholecystopathy, regional enteritis, and the possibilities of surgical treatment are discussed in particular.

In a large surgical series Ceccarelli and Fabris (2) found that among patients over 60 years of age 4.9% died in connection with the operation. Adding to these cases patients who deteriorated and were discharged as unsuitable for further treatment, the mortality rate increased to 7.5%, mainly because of the large number of cancer cases. Severi (13) has studied the causes of operative deaths in old age. On the basis of statistics collected in connection with his study, he could state that during the periods 1944-1948 and 1949-1954, the percentage of patients over 65 years of age who came to operation had increased from 8.6 to 17.0. As regards hernia and laparocele, there was an increase of strangulated hernia from 10.2% in patients below 65 to 36.5% in patients above this age. The increase of complications in gastro-duodenal ulcers and in cholecystitis was equally striking: from 10.8 to 41.9% in the former and from 22.2 to 50.9% in the latter. Furthermore, there was a notable increase of emergency operations during old age from 16.6% to 20.4%. The mortality was 18.0% in patients over 65 and 4.1% in younger patients. In other operations the mortality was 4.1% and 3.2%, respectively.

Magistris (7) has reported that approximately 42% of all patients over 70 years in a surgical ward or in a surgical first aid station were the victims of accidents. Frequently, they had had only a minor trauma which caused fatal injuries (mortality rate of 9%). In most cases, shock was pronounced, and pre-existing disease rendered immediate and effective surgical intervention impossible.

Concerning the treatment of peptic ulcer in elderly patients, Liavaag (6) has emphasized that today the mortality has decreased so much that operative treatment on a greater scale than hitherto can be recommended. Quite particularly, patients who have had massive hemorrhages should be advised to undergo operation during a remission as a prophylactic measure against further hemorrhages. Moreover, the operative treatment of gastric ulcer ought to be extended, partly because of the risk of cancerous transformation and partly because of the difficulties in differentiating between gastric ulcer and carcinoma. In Liavaag's series—58 resections and 10 gastrectomies—there were two postoperative deaths, one in each group. Postoperative complications were neither more numerous nor more serious than those in a resection series of younger patients.

A number of Italian workers have reported on geronto-surgical problems: Malan (surgery in old age, 8), Venturini (preoperative management, 14), Fior and Calearo (prognosis in operations on neoplasms on the neck, 3), Govoni and Zaccharelli (cholecystography, 4). Parenti (12) has discussed the surgical treatment of chronic biliary tract diseases. His own results were favorable and demonstrated the value of surgery, even in the oldest patients. Guffanti (5) has been concerned with the physiopathologic diminution of the senile stomach. Thereby, its value as an organ is greatly reduced, and this is a fact which speaks in favor of operation instead of conservative management.

## REFERENCES


1. Brotherus, J.: Acute Appendicitis in Old Persons. In: *Old Age in the Modern World*, E. and S. Livingstone Ltd., London, 1955, p. 560.
2. Ceccarelli, G., and Fabris, F.: Considerazioni su un Decennio di Chirurgia Geriatrica. *Fourth Congress, International Association of Gerontology, Merano, 1957 Summaries*, p. 105-106.
3. Doberauer, W.: Chirurgische Eingriffe am sympathischen Nervensystem alter Menschen. In: *Alter und Krankheit*, W. Doberauer, ed. Verlag Gesellschaft zur Förderung wissenschaftlicher Forschung. Vienna, 1957, pp. 273-300.
4. Fior, R., and Calearo, C.: Prognosi Chirurgica delle Neoplasie Cervicofacciali in Soggetti Anziani. *Giorn. Gerontol., 3:* 169-174, 1955.
5. Govoni, A., and Zaccarelli, B.: La Colecistografia nell'Età Senile. *Giorn. Gerontol., 2:* 442-451, 1954.
6. Guffanti, A.: Valore di Organo della Stomaco Senile nella Terapia Chirurgica della Affezioni Gastriche nei Soggetti di Età Avanzata. *Giorn. Gerontol., 5:* 201-206, 1957.
7. Liavaag, K.: Indikasjoner for Kirurgisk Behandling av Ulcus hos Eldre. *Nord. med., 54:* 1854-1855, 1955.
8. Magistris, F.: Injuries Due to Accidents in the Aged. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries*, pp. 188-189.
9. Malan, E.: L'Intervento Chirurgico nel Vecchio. *Giorn. Gerontol., Suppl. 7:* 55-62, 1955.

10. Malan, E., Occhipinti, S., Serrano, S., and Aroldi, A.: L'Intervento Chirurgico nel Vecchio. *Giorn. Gerontol., Suppl. 6:* 1-126, 1955.
11. Moritsch, P.: Operationsindikation im Alter. In: *Alter und Krankheit,* W. Doberauer, ed. Verlag Gesellschaft zur Förderung wissenschaftlicher Forschung. Vienna, 1957, pp. 261-272.
12. Moritsch, P.: Die Therapie der Durchblutungsstörungen nach dem 70 Lebensjahr. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries,* pp. 200-201.
13. Parenti, G.: Sul Trattamento Chirurgico delle Affezioni Croniche delle Vie Biliari e della Colecisti in Pazienti Ultrasettantenni. *Giorn. Gerontol., 5:* 194-200, 1957.
14. Severi, A.: The Cause of Death During Surgery in Old Age. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries,* pp. 259-261.
15. Venturini, G.: Considerazioni in Tema di Gerochirurgia. *Giorn. Gerontol., 3:* 297-306, 1955.
16. Wulff, H., Lundskog, O., and Merits, F.: Kirurgien över 65 Ar. *Nord. med., 49:* 372, 1953.

## ANESTHESIA

On the basis of a series of 200 patients between 60 and 92 years of age, Halevy and Nicolesco (1) recommend tracheal intubation and ether as the best method for general anesthesia. This method is said to assure good oxygenation and to avoid anoxia, the most important factor in this problem. Neubauer (2) also prefers intratracheal anesthesia. In selecting the method of anesthesia, the anesthetic itself and its dosage, consideration has to be given to the changes usually found in the organs of patients over 70 years of age. She mentions a special type of local anesthesia "potentiated local anesthesia" with xylocaine combined with a lytic mixture (dolantin, phenergan, chlorpromazine). In amputation of limbs, Neubauer prefers "potentiated ice anesthesia." Spangano, Bernasconi, and Malesani (3) have published a comprehensive study based on the anesthesia of 1,467 cases. Their results were good.

## REFERENCES

1. Halevy, S., and Nicolesco, G.: Des Problemes de l'Anesthesie des Vieillards. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries,* p. 157.
2. Neubauer, T.: Das Narkoseproblem im höheren Lebensalter. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries,* pp. 205-206.
3. Spangaro, P., Bernasconi, M., and Malesani, G.: L'Anestesia in Chirurgia Geriatrica. *Giorn. Gerontol., 5:* 684-716, 1957.

## URINARY TRACT AND KIDNEYS

de Gironcoli (2) has published a monograph on the prostate in old age. Olbrich (5) has studied the renal function in prostatism. His investigations aimed at showing the effect of mechanical obstruction on renal function. This was measured in the following ways: 1) blood flow to the kidney, 2) the rate of glomerular filtration, and 3) the maximal tubular excretory capacity. The subjects on whom the investigations were carried out belonged to the following groups: (a) those who had a palpable enlargement of the prostate, but no clinical symptoms, b) those with a palpable enlargement of the prostate with clinical symptoms, namely frequency of micturition, difficulty in starting the act of micturition, dysuria, and double stream or dribbling, (c) those who had the same clinical symptoms and in addition suffered from a urinary infection, proved by bacteriologic investigation, and (d) those in acute urinary retention. From all these patients who have been operated on, measurements had been taken, before and after operation, of renal function. The results were most revealing: group (a) showed a great variation in the renal function as is always shown in people in this age group. The infected group showed a considerable impairment of maximal tubular excretory capacity, which confirms the theory that these people develop a tubular nephritis. This leads to a considerable change in the salt-water balance of the patient and can be considered as the pre-uremic state. The difference between the preoperative and the postoperative patients depends on the time when the measurements have been taken after operation, but it certainly shows that after operation an improvement in renal function takes place which affects especially the maximal tubular excretory capacity and the blood flow to the kidney.

### *Urinary Incontinence*

Urinary incontinence is a very common disorder in old age and one which is a great nuisance not only to the old people themselves, but also to their surroundings. A thorough study of bladder function in the aged has been reported by Wilson (6) who used cystometric measurements. The cause of increased frequency as well as precipitancy of micturition, often accompanied by incontinence, he found to be mainly overactivity of the neuromuscular

mechanism of the bladder, whereas sphincteric weakness was important in only a small minority of the cases. The overactivity of the bladder mechanism results from diminution of cerebral cortical control and from the local irritative conditions of the bladder and its outlet. These factors operate to different extents in different cases, but commonly the former plays the more active role. Impaired cortical control may be due to structural changes within the nervous system and to a functional loss of inhibitory power. An impaired mental state is a contributory factor, as also is the confinement of the elderly patient to bed. In many cases of overactivity of the reflex bladder mechanism, function improved as a result of gradual distension of the bladder with fluid and inhibitory reeducative training.

Eckerström (3) has reported that about 25% of all patients at the geriatric clinic in Gothenburg, Sweden, had incontinence of urine. It was caused in 90% by functional changes or lesions of the central nervous system. On the basis of cystometric investigations, this author states that exercise therapy with the cystometer is of great importance. If the patient is uncooperative, the common drainage methods have to be used. Brocklehurst (1) published in 1951 a valuable monograph on incontinence in old people.

It has been claimed that estrogens have a beneficial action on urinary incontinence in elderly women. According to Hjorth and Møller-Christensen (4), androgenic substances exert the same favorable effect. In a series of patients from De Gamles By, Copenhagen, the incontinence was completely cured in one-third and improved in one-third, whereas in the remainder the treatment was ineffective. In male patients, on the other hand, no improvement could be obtained with androgens. In such cases, gonadotrophic preparations are often, but by no means always, effective (unpublished observations).

REFERENCES

1. Brocklehurst, J.: *Incontinence in Old People.* E. and S. Livingstone, Ltd., Edinburgh, 1951.
2. de Gironcoli, F.: Prostata e Senilità. *Giorn. Gerontol., Suppl. 7:* 63-66, 1955.
3. Eckerström, S.: The Urinary Incontinence Problem in Old Age. *Third Congress, International Association on Gerontology, London, 1956, Abstracts,* p. 79.
4. Hjorth, A., and Møller-Christensen, E.: Ueber die Wirkung von androgenem Hormon auf Urininkontinenz bei alten Frauen. *Gynaecologia, 142:* 1-11, 1956.
5. Olbrich, O.: Renal Function in Prostatism. *Third Congress, International Association of Gerontology, London, 1956 Abstracts,* p 194-195.
6. Wilson, T.: Incontinence of Urine in the Aged. *Lancet, 255:* 374-377, 1948.

GYNECOLOGY

Sora (2) studied the vaginal cytology in old age. Zacherl and Gitsch (3) gave a review of the trophic disturbances of the female genitals and their treatment. Palmrich (1) described the gynecologic causes of incontinence of the urine in old women.

REFERENCES

1. Palmrich, A.: Inkontinenzerscheinungen bei alternden und alten Frauen. In: *Alter und Krankheit,* W. Doberauer, ed. Verlag "Gesellschaft zur Förderung wissenschaftlicher Forschung." Vienna, 1957, pp. 219-224.
2. Sora, P.: Rilievi sulla Citologia Vagginale nelle Donne in Età Senile. *Giorn. Gerontol., 2:* 81-83, 1954.
3. Zacherl, H., and Gitsch, E.: Trophische Störungen des weiblichen Genitales im Alter und ihre Behandlung. In: *Alter und Krankheit,* W. Doberauer, ed. Verlag "Gesellschaft zur Förderung wissenschaftlicher Forschung." Vienna, 1957, p. 209-218.

DISEASES OF THE EAR, NOSE, LARYNX, AND EYES

The senile ear was mentioned in a book of Pietrantoni and Arslan (5), and diseases of the nose and larynx in old people were described by Piatti (4).

Degeneration of the senile cornea was studied by Edmund (1), and the senile cataract by Orzalesi (3). Orma (2) showed that primary glaucoma usually has its onset between the age of 55 and 75 years. In a study carried out at the geriatric outpatient department, Helsinki, glaucoma was found to be present in 4.6% of the patients. Primary glaucoma is the most important single cause of blindness in many civilized countries. The condition is preventable to a large degree, but the effect of therapy depends on early diagnosis. In the early stage chronic glaucoma is asymptomatic or the symtoms are very slight, and the patients do not visit ophthalmologists for their ocular symptoms. Thus the only way to detect the condition early is to include routine tonometry in the general physical examination whenever the

patient's age exceeds 40 years. A review of the human eye changes after the 60 years age was given by Pillat (6).

REFERENCES

1. Edmund, J.: A Case of Primary Band Shaped Opacity of the Cornea. *Acta ophth. scandinav., 28:* 209-214, 1950.
2. Orma, E.: Glaucoma, a Geriatric Problem. *Nord. med., 56:* 1071-1072, 1956.
3. Orzalesi, F.: Nuove Vedute sulla Eziopatogenesi della Cataratta. *Giorn. Gerontol., 4:* 195-217, 1956.
4. Piatti, A.: Gerontologia otorinolaringologica. *Giorn. Gerontol., 2:* 126-132, 1954.
5. Pietrantoni, L., and Arslan, M.: L'Orcchio Senile. *Giorn. Gerontol., Supp. 10:* 1-63, 1956.
6. Pillat, A.: Das menschliche Auge nach dem 60. Lebensjahr. In: *Alter und Krankheit,* W. Doberauer, ed. Verlag "Gesellschaft zur Förderung wissenschaftlicher Forschung." Vienna, 1957, pp. 21-30.

## ORTHOPEDICS

During recent years orthopedic as well as general surgery has been extended to geriatric tasks. Flemming (2) has emphasized that orthopedic surgery should be invoked before disability has become crippling and while the will to recover remains. A feature such as happiness of the patient cannot be measured as a statistical figure, but when considering crippling disabilities in the old it is really their mobility and capacity to get about, their independence, and their relative freedom from pain that should be the guiding criteria. Surgeons are, however, so obsessed by the question of mortality statistics that treatment is often denied to the old for fear that they may die as a result of it. Hesitation is based partly on the fear that the skeletal system is incapable of repair or improvement in old people. This is a fallacy. Experience gained from fractures in old people shows that power of repair remains throughout life, if the vascular supply is good. Long periods of immobilization are not well tolerated, but actual operations, if indicated, can be safely performed. If the patient is already confined to bed, the indications for treatment are very clear, because the patient has nothing to lose.

One of the most important orthopedic problems in geriatrics is the treatment of osteoarthritis of the hip and fracture of the femur. According to Chiari (1) 30% of old patients who sustain fracture of the femoral neck develop necrosis of the head. In his opinion, reestablishment of motion in the hip joint in old age is desirable, and he recommends alloplasty using acryl, stating that this affords a mobility of up to 90° in 60% of the cases. In Denmark, the use of acrylic prostheses has been a disappointment because of marked wear and loosening of the prosthesis. Instead, Movin (4) recommends alloplasty with a metal prosthesis as the best procedures for aged patients. Mohing (3) prefers arthrodesis.

REFERENCES

1. Chiari, K.: Orthopädische Behandlung im Alter. In: *Alter und Krankheit,* W. Doberauer, ed. Verlag "Gesellschaft zur Förderung wissenschaftlicher Forschung." Vienna, 1957, pp. 247-254.
2. Flemming, C.: Orthopedic Surgery in the Elderly. *Third Congress, International Association of Gerontology, London, 1954, Abstracts,* p. 95.
3. Mohing, W.: Operative Treatment of Arthrosis Deformans of Hip-Joint in Elderly People. *Fourth Congress, International Association of Gerontology, Merano, 1957, Summaries,* pp. 198-199.
4. Movin, R.: *Alloplasty of the Hip as Treatment in Suitable Cases of Fracture of the Neck of the Femur and in Sequels of Such Fracture.* Munksgaard, Copenhagen, 1957, pp. 1-275.

## REHABILITATION

During recent years, a great deal of attention has been paid to the rehabilitation of elderly patients in Europe. In this field, England has been the leading country. At the West Middlesex Hospital, Isleworth, Middlesex, a geriatric clinic was established as early as 1936. Very intensive rehabilitation work has been carried out by its chief, Warren (5), who has obtained particularly good results in rehabilitating the elderly double amputee. She uses modern short pylons as soon as the patient is able to balance himself well and to stand on his stump ends. The best results were obtained when treatment was energetic, continuous and instituted soon after amputation; the after-care of the double amputee is also very important.

Cosin (3) of Oxford has also performed intensive geriatric rehabilitation. The average bedfast stay of people over 60 years of age admitted to a geriatric unit was found to be about 44 days in the first 6 months of hospitalization. The average percentage of permanently bedfast patients 6 months after admission to a geriatric unit was about 3% of the admissions. Porsman (4) has submitted the results of physical therapy at De Gamles By, Copenhagen. His study was concerned mainly with the rehabilitation of patients with hemiplegia, osteoarthritis of the hips, knees, and spine, rheumatoid

arthritis, and fractures of the lower limbs. The results were extremely encouraging, especially when considering that the rehabilitation was not commenced until after the patients had been given up by a general hospital. Butler (1, 2), discussing the value of rehabilitation within geriatrics, stresses the great importance of collaboration between the doctor, physiotherapist, and occupational therapist. A geriatric hospital working effectively will be in a position to receive surgical cases from the general hospital, for preoperative care before the proposed operation as well as for intensive after-treatment. An active geriatric hospital aiming at rehabilitation will also be able to support the continuous care of out-patients and the care of old people in their homes.

REFERENCES

1. Butler, P.: Vård och Rehabilitering av Äldre Sjuka och Partielt Arbetsföra. *Nord. Med., 49:* 583-588, 1953.
2. Butler, P.: Activ Aldringsvård och -kirurgi Belyst av Några Fall. *Nord. med., 54:* 1053-1055, 1955.
3. Cosin, L.: Statistical Analysis of Geriatric Rehabilitation. *J. Gerontol., 7:* 570-578, 1952.
4. Porsman, V.: Statistical Results of Rehabilitation in "The Old Peoples Town" in Copenhagen. In: *Old Age in the Modern World,* E. and S. Livingstone Ltd. London, 1955, pp. 571-574.
5. Warren, M.: The Management of the Elderly Double Amputee. In: *Old Age in the Modern World,* E. and S. Livingstone Ltd. London, 1955, pp. 562-569.

# PSYCHOLOGICAL AND SOCIAL GERONTOLOGY IN EUROPE

A. T. WELFORD, M.A.

*(From the Psychological Laboratory, Cambridge University, England)*

It is necessary to begin this survey with a conditional apology. Until the founding last year of the journal *Gerontologia* and of the forthcoming *Vita Humana*, there has been no fully international focus of gerontological publication in Europe. Substantial collections of work have been included in the report of the Third Congress of the International Association of Gerontology under the title of *Old Age in the Modern World* (93) and will be contained in the forthcoming report of the Fourth Congress (101), but, for the most part, accounts of research are scattered widely, having been published either as monographs or in journals of the research workers' own disciplines. I am thus conscious that I may have omitted some important work, and, if so, I must offer apologies to those concerned. I am aware also that research in Europe has been done against a background of the work of a number of American pioneers whose studies are now classical.

Studies within the scope of this survey have been made in many countries, but it is fair to say that by far the largest quantity of work has been done in Britain. This is due mainly to the foresight of the Nuffield Foundation and Lord Nuffield's personal interest in problems of aging, which resulted in the sponsoring of research projects around the end of the second World War, in advance of general recognition that the study of aging was an urgent need. The aim in these projects was, as I think it has been in most European research on aging, rather severely practical, namely, how to prevent the increasing number of old people in the population from becoming an undue burden upon the community. The work has thus taken the form of, first, surveys of the condition of elderly people with a view to ascertaining their needs and setting the pattern of welfare services; second, studies to determine the work potential of older people and to make possible a longer working life; third, the seeking of means of rescuing older people from long stays in hospitals. This last is mainly a medical matter, but from the psychological standpoint it had the effect of raising interest in the assessment of mental deterioration in clinical senile states.

Fortunately, the second and the third of these types of work were recognized as involving fundamental questions of human capacity and were approached from this standpoint by a very substantial amount of the research undertaken. The work may therefore be divided for our present purposes into four classes, with which we shall deal in turn: 1) attempts to measure, usually by means of tests, various aspects of human capacity, either in an absolute sense on a representative population, or with a view to comparing one measure with another; 2) researches, usually experimental, aimed at analyzing the "mechanism" lying behind the changing capacities; 3) studies of the employment and retirement of older people; and 4) social surveys of the condition of old people in their homes.

Almost all these researches have been essentially short-term probes, for the most part done by those whose main interests have lain elsewhere. The advantage of this has been that the research workers have brought to gerontology a wide range of ideas; the disadvantage has been a lack of continuity and follow-up of the leads which many of the studies contained. The method has, in practically every case, inevitably been cross-sectional. This is, however, not wholly unsatisfactory. The present author has pointed out elsewhere (144) that longitudinal methods suffer from a number of serious disadvantages so that, although they are essential for the answer to certain types of questions, they need to be used with caution. In particular, the fact that they involve testing the same subjects twice with the same material means that aging effects may be confused with improvements due to learning. Just how serious the effects of repeating the same test twice may be has been shown by Heim and Wallace (50, 51) whose findings throw doubt on the validity of all longitudinal researches using intelligence tests.

1) MEASURES OF HUMAN CAPACITY

The first survey of which full accounts are available is that of Galton (39, 40) who, in 1884, took a series of measures of psychomotor performance from visitors to an International Health Exhibition—and achieved what few, if any, of his successors have done in making his subjects pay to be tested! His results show relatively little change with age, but clearly his sampling was deficient. Comparison between results obtained for his different measures would, nevertheless, seem to have some validity, and inspection of the work done on his data by Koga and Morant (73) and by Ruger and Stoessiger (114) is well worth while and an object lesson in "brass-instrument" statistics. More recent studies may be divided into two main types: (a) applications of tests or batteries of tests to substantial populations of normal people; (b) attempts to devise means of distinguishing between normal old people and those suffering from clinical senile conditions or between one type of clinical condition and another.

a) Among the first type may be mentioned the substantial work of Gemelli and Cesa-Bianchi, who have produced a thorough tabulation and correlation of the results of a battery of sensorimotor tests on a population ranging from the twenties to the eighties (17, 41). Cesa-Bianchi also made a very intensive study, using an Italian version of the Weschsler-Bellevue scale and the Rorschach test, of a group with ages ranging from seventy to eighty-eight years (14, 15, 16). He observed in the latter study a decrease of activity from the age of seventy onwards, which produced initially some signs of frustration, but he obtained evidence of readjustment in the late seventies. He also notes that the top 25 per cent of his sample showed less deterioration amongst the oldest subjects, probably due to the death of the most deteriorated individuals.

A second study upon predominantly psychomotor performance (Rorschach and Thematic Apperception Tests were also given and electroencephalograms were taken) is that by Von Fieandt (34, 35), who found that speed on a number of simple performances, such as clapping or tapping at the subject's own preferred rate, and also simple reaction time and speed of walking declined little until the eighties. He found that such declines in "tempo" as did occur were not associated with accuracy of judging time intervals.

A more intimate study of various aspects of performance aimed at assessing changes in the method and manner of action from middle to old age has been reported by Munnichs (86). Perhaps the most extensive study using batteries of tests has been that by Pacaud (97, 98, 99). She tested a large group of subjects ranging from the teens to a group labeled "over forty-five" on a battery including simple sensorimotor, intellectual, and memory tasks. Detailed results of these are presented in percentile scores for the different age ranges. They do not deal with what would normally be termed old age but cover the important and interesting period in which performance rises to a peak and subsequently begins to decline. Pacaud has been particularly interested in the relation of test results to level of education. The association of performance with education was found to be negligible in the sensorimotor tasks but substantial in most of the others. It was found that, in all cases where an association occurred, it either remained the same in different age groups or progressively diminished with age. No cases were found in which it became greater.

Of studies using intelligence tests, probably the best known and most extensive is that of Foulds and Raven (37, 38, 103), who obtained scores for large groups of subjects on Raven's Progressive Matrices test and also on the Mill Hill Vocabulary Scale. Their results show clearly that, whereas the Matrix scores fell with age, the vocabulary scores remained high and that the fall of Matrix scores for the less able subjects was greater than for the more able. The Progressive Matrices test is an untimed, nonverbal test, which factor analysis has indicated as a rather pure test of Spearman's "g." The accelerating decline with age found by Raven with this test may be compared with the linear decline found by Vincent (138) when using a timed, verbal intelligence test. Vincent's result is in line with those of earlier American work using tests of a similar kind carried out by Jones and Conrad (61) and by Miles and Miles (82). As regards other work on intelligence tests, we have already noted the study by Cesa-Bianchi. Work is also being done in Holland by Verhage (135) on devising an intelligence test suitable for adults in that country.

A very substantial survey has been carried out by van Zonneveld (150). Although mainly concerned with the medical and the social condition of people over sixty-five, this survey included also a number of items, mainly on memory, from the Wechsler-Bellevue Scale and thus provided a large sample result showing declines in performance at these items from age sixty-five onwards.

What promises to be another interesting survey of the same type is being undertaken in Germany by Riegel (109), who is combining a study of performance on the Wechsler scale and on verbal and word-association tests with indications of attitudes, interests, social data, and life-history.

The authors of most of these studies have been cautious about drawing deductions regarding interrelationships between the results of one test and another and have not really attempted to use their results to identify general capacities running through several different test performances. This caution is perhaps understandable in that, while our interest is in *capacity*, all we can measure is *performance*, and the functional relationship between these two is by no means always straightforward. As will be noted again later, until the principles of such relationships are known, we cannot safely infer back from the test scores to the abilities underlying them or, indeed, construct any concept of what the basis of such abilities may be. At this stage, however, explorations with batteries of tests are undoubtedly valuable and form an important preliminary to the more precise work which it is hoped may follow.

b) Attempts to assess senility and to compare one form of senile breakdown with another have been essentially psychiatric in orientation, and we shall only briefly touch on them here. They appear in general to confirm the picture of studies made on normal old people, and it is very doubtful whether any clear qualitative differences are to be recognized. There are, of course, substantial quantitative changes between clinical senility and normal old age, which may, from time to time, produce apparent qualitative results due to the reorganization of performance that may result from deterioration (32, 33).

Halstead, in an attempt to devise a battery of tests to assess senility, showed that a convenient index of deterioration is given by the *relationship* between vocabulary and Matrix scores (48)—a finding parallel to that of Foulds and Raven for normal people (37, 38). Halstead also showed that discrimination between less and more advanced seniles is much better achieved by using tests requiring the rearrangement of familiar sequences than when sequences are used in the customary manner. For example, the ability to repeat the months of the year backwards gave a clear differentiation, whereas repeating the months in the normal order did not (49). He found many individual differences in the pattern of results from his battery of tests, and there was little similarity between the score profiles of his different subjects.

Loss of power to abstract has been indicated as a distinguishing mark of clinical senile conditions both by Eysenck in a factor analysis of a battery of tests including the Matrix (33) and by Hopkins and Post using Goldstein tests (55); although Shapiro, Field and Post found this characteristic does not distinguish organic from functional cases (116), and Kelly and Pinkerton produce evidence that other factors, such as emotional reaction to the task, may affect performance (68). Tests of memory function, although showing declines with age (117, 150), have been found by Inglis, Shapiro and Post (58) not to distinguish well between functional and organic cases. A relation between degree of deterioration in senile dementia patients and abnormally slow EEG rhythms has been found by McAdam and McClatchey (78) and confirmed by McAdam and Robinson (79, 110). Differences have also been shown by Orme between elderly depressives and true senile dements on a battery of tests including Matrix, vocabulary, and Rorschach (94). The same author finds differences between old subjects and children on the Rorschach test and points to the fallacy of thinking of old age as "second childhood."

The loss of power to abstract appears to be a recurrent finding in tests applied to seniles, but the question remains: How far is this peculiar to seniles as opposed to being a normal concomitant of old age? It seems likely that the answer depends very much upon the difficulty of the test. We may, for example, note that in a series of studies Bromley (9, 10, 11) has obtained evidence of a fall among normal people from young adulthood onwards in "abstractness" of performance at the Matrix test, in giving meanings to proverbs and in a classi-

fication test. In the last of these tests there was also a loss of "fluency" with age, noticeable in the smaller number of different classifications made. These tests were probably more difficult than those which have been used with seniles and thus show effects among normal old people which do not appear with easier tasks.

The real problem that remains is to define the nature of the loss which occurs when abstraction is replaced by "concrete" behavior. What precisely does a subject have to do in order to "abstract" in the sense required by these tests? Does this power depend upon a number of distinct capacities which may be present or absent in an all-or-none way? If so, the implication would be that true qualitative differences of performance could be found. Or is the power to abstract dependent upon "mechanisms" which may vary continuously in their efficiency so that qualitative differences of performance are underlain by changes of capacity which are fundamentally quantitative in nature?

## 2) EXPERIMENTAL STUDIES OF PERFORMANCE

### a) *Speed and Accuracy of Movement*

It has been known since the pioneer experiments of Miles (81) that slowing with age varies from one task to another. A series of researches by the present author and his colleagues have attempted to take up this fact and, by close analysis of performance, locate and ascertain the causes of slowing with age at sensorimotor tasks (141, 145). The method has been to take relatively complex activities and to analyze them into what seem to be their significant component parts. The timing of these parts can then be studied separately without removing them from their context. The difficulties are thus avoided of trying to synthesize a picture of age changes at more complex tasks from the examination of isolated actions.

The initial experiments in the series were made by Brown, who noted that the pattern of action might change with age much more than over-all achievement and that, where the subject was free to choose between faster but less accurate or slower but more accurate performance, older subjects tended to follow the latter course. They were thus able, to some extent, to compensate for slowness by wasting less time in making errors. These results confirmed a well-known tendency, but they also pointed to the fact that such compensation could operate only when the subject is able to vary the precise form of his actions within fairly wide limits. Where such latitude is lacking, older subjects tend to be both slower and less accurate than younger. The actual balance struck between speed and accuracy does not always progress evenly with age; for example, the transition from the twenties to the thirties may be marked by maintenance of speed at the expense of accuracy, whereas the transition to later ages may be marked by a fall of speed with the level of accuracy restored.

A series of experiments by Szafran (126), Leonard (75), and Singleton (122, 123) have separated reaction time and movement time in serial reaction tasks. Under these conditions there appeared to be a small but consistent rise of reaction time with age, which was more or less continuous from the twenties onwards, together with little or no change of movement time, at least until the fifties. It seemed clear from this that the limitations upon speed of sensorimotor performance in old age were due to central rather than peripheral factors. Further work by Jeeves (145) has shown the limitation to lie in the time between the appearance of a signal and the beginning of the responding action rather than in any after-effect of movement. Experiments by the present writer (145) have indicated that the slowing was not the result of excessive caution, but must be attributed to a lowering of channel capacity with age.

It would be reasonable to infer from these results that, under conditions where performance was paced by some external agency so that each action or cycle of actions had to be completed within a rigidly fixed time, the fall of achievement in old age would be very much more severe than when flexibility of timing is possible. A further experiment by Brown has confirmed that this is so (12). Similar indications have been obtained in studies on the employment of older people which will be mentioned later.

It appears from Singleton's experiments (122, 123) that some additional cause of slowing operates amongst subjects over the age of about sixty. What this is, is not certain, but several possibilities would appear to merit further studies. One is that subjects of this age find difficulty in co-ordinating complex actions into larger rhythmic units. Another and more likely possibility is that they become unable to over-

lap the central organization of one action with the execution of a previous action. Their performance thus proceeds by a series of stops and starts, giving a jerky effect instead of the more flowing, smooth performance associated with younger age groups.

The evidence is conflicting with regard to the actual form that the slowing with age takes. N. Welford found that, for a simple guided movement, slowing at tasks with different degrees of difficulty was proportional in age groups from the twenties to the sixties and was thus consistent with a straightforward lowering with age of the "information" capacity of the sensorimotor system (145). Studies by Crossman and Szafran (30), however, have indicated that the slowing with age at a sorting task is best thought of as the addition of a "constant" to the time taken for tasks of different complexities, so that slowing is proportionately less with difficult tasks than with easy. It seems reasonable to infer that we are dealing not with a single source of slowness but with several different central mechanisms, each of which is determining the speed of performance under different conditions; we may tentatively distinguish between perceptual discrimination, translation from perception to action, and the coordination of motor movement.

It is also unclear what is the relationship between reaction time and subsequent action and whether this relationship changes with age. Some evidence suggests that the form of the action may be of little importance (145). Studies carried out by Griew (47) indicate, however, that in certain circumstances the increase in complexity of action makes a substantial difference to reaction time, especially among older people. It is clear that the whole matter of slowing with age would repay further research. Time and accuracy taken together are a sensitive indicator of age change, and the study of the ways in which they change with increasing difficulty at various types of tasks would seem likely to yield important insights into the mechanisms of changing performance with age.

b) *Relationships between Display and Control*

It has been found in studies not specifically concerned with aging that the relationship between what is seen and the responding action required affects speed of performance. Ruch (113) has also shown that, in the case of mirror tasks, older people are at a disadvantage. It is commonly assumed that Ruch's finding is due to the fact that the subjects must learn the unfamiliar relationships produced by the mirror and that older subjects take longer to learn than younger. Such a view seems, however, to miss the essential point at issue. If certain display-control relationships produce slower performance than others, how is the extra time spent? What does the subject have to do in the one case which he does not have to do in the other? If older people take disproportionately longer, do they, with practice, gradually come to equality with younger people, as would be expected if their difficulty was due purely to slowness of learning? Or do they remain slower even when improvements with practice have become virtually complete, as would be expected if difference in the rate of learning was not an adequate explanation? Further, if the latter is found to be true, are they taking longer to do the same thing as young subjects, or are they, in fact, doing something different? The evidence at present available does not get very far towards answering these questions, although experiments by Szafran (127) have shown clearly that poorer performance by the older subjects is not to be attributed to slowness of learning. Experiments by Kay (65, 66) have shown that, when complications between display and responding action are introduced, there may be very markedly disproportionate effects with age as the difficulty of the task increases.

"Difficulty" in all these cases seems to be associated with the introduction of intermediate "steps" between the initial perception of the display and the final choice of action. For example, in mirror tasks the display has, as it were, to be "turned round" in the subject's imagination. It is, however, not clear how far the disproportionate effects observed by Kay are due simply to an increase in the *number* of intermediate steps or to inconsistency among the various steps required in his more difficult tasks.

c) *Perception*

It is noteworthy that experiments in perception have moved away from elementary sensory functions to the study of central processes identifying and giving meaning to incoming sensory data. The field was opened up with an experiment by Weston (146), who presented his subjects with the task of cancelling

Landolt rings. He found that speed of performance fell with age from the twenties to the forties, even though the more usual tests of vision (Snellen charts and Jaeger Test Types) showed no decline and despite due allowance having been made for slowing of the actual movements involved in performing the task. The fall in speed was accentuated by dim illumination, poor contrast or small size of ring; when two or more of these conditions were combined, the fall was very great. It has been argued by Gregory (44, 45, 46) that, since visual acuity is dependent upon differential brightness threshold, the ability to perform fine visual tasks should be linked with this. In a series of experiments he has confirmed the rise of differential threshold among older people, and the form this has taken has indicated clearly that it cannot be due to opacity of the eye media or contraction of the pupil with age. It might be the result of light scattering in the eye, but the similarity of results that he has obtained for sight and hearing, and the quantitative values involved, suggest that the changes are of more central origin. Gregory's results, together with those obtained by Crossman and Szafran (30), who used a discrimination task not involving sensory thresholds, suggest an explanation of perceptual changes with age in terms of a falling signal-to-noise ratio. The theory associated with their names is that these age changes are due to the fact that signals are received against a background of random neural activity or "neural noise." As age advances, the level of signal tends to fall and the level of noise tends to rise; to combat these conditions older people either have to seek stronger signals (128) or to cumulate data over a longer time.

The requirement of longer time, on a very much extended scale, has also been shown in experiments by Wallace (140), in which meaningful pictures were presented in a tachistoscope. Subjects in their sixties and seventies required some fifteen times the length of exposure needed by subjects in their twenties under conditions where amount of light and acuity could not be limiting factors. We may conceive of identification or the giving of meaning as a classifying process in which the object seen is put into one of a number of categories. Older people not only require more time to do this but also seem to find greater difficulty in changing from one classification to another. This latter point was noted by Verville and Cameron (136), was shown in Wallace's experiments, and has been confirmed recently by O'Doherty (145). We do not know whether this difficulty is due to the longer experience of older people, giving them a wider range of classes from which to choose or biasing in favor of one against others, or whether some impairment occurs in the "selection" or "search" mechanism. A number of considerations make the latter view a little more probable than the former, but the question is by no means decided.

Some further research on perception is in progress at Liverpool (80).

### d) *Learning*

A number of researches have indicated the need to look in more detail at the processes of learning in younger and older subjects, if the extent and nature of the limitations that occur with age are to be properly understood. The first of these is an experiment by Kay (63), who noted that his older subjects in the fifties and sixties required longer time and more trials and made more errors in learning a rote task. His detailed study of the actual errors made indicated that *something* had been learned at the beginning of the task very quickly by old as well as young, and that the difficulty for the older subjects lay not in learning but in modifying what they had learned at the points at which it was wrong. Kay's work has been substantially extended by von Wright (149).

Further evidence that some things are learned as quickly by old as by young is contained in results by Speakman (125) and by E. Belbin (4), both of whom found that difficulty shown by older people in reproducing in words what they had learned was not reflected in their ability to use material in circumstances which did not require verbal recall. Difficulty of verbal recall by old people has also been reported by Bromley (9). The present writer has suggested that these results occur because recall of material in words demands the retention of far more data than are normally required for its practical use and that the essential limit of learning amongst older people lies in the *amount* that they can learn at any one time. This amount, in turn, seems to depend upon the capacity of the short-term retention mechanisms which must bridge the gap between per-

ception and registration in an enduring form. The capacity of these short-term retention mechanisms seems to diminish markedly with age under certain conditions, which we shall note later.

It must be emphasized that many learning difficulties are encountered not in the act of learning itself but in the comprehension of the material, especially when this is given by demonstration or lecture or other means where the subject does not have control of the pace of instruction (143). Under these conditions he will miss points from time to time and will fill in the resulting gaps by falling back on his general fund of past experience. This will make him appear to suffer from "negative-transfer" effects but will, in fact, have been due to slowness of perception and comprehension. The removal of such limitations can yield striking results when training older people, as is evidenced in experiments by E. Belbin (5). In these, the replacement of verbal instruction by actual performance of the task (invisible mending) under simplified conditions greatly improved the performance of middle-aged and older people and did in fact raise the achievement of the older above that of younger trainees in a number of respects.

It has been believed for a long time, but not satisfactorily demonstrated, that, once a skill is acquired, it survives well into old age. Evidence for this is not readily obtained from experiments, except on a very long-term longitudinal basis, but some confirmation has been obtained by Clay (27) in a study made in two printing works. In these the labor turnover was so low that a cross-sectional study was unlikely to be vitiated by the progressive selection that occurs in most industrial operations (71). There were some falls of performance during the later decades—fifties and sixties—but these were not large. We may note at this point that experiments by Verzar-McDougall (137) in which rats were required to relearn mazes at different periods of their lives usually showed good retention up to a relatively late age. Amongst very old rats, however, there appeared to be sharp differences of retention, some remembering well and others seeming not to remember at all: it would appear that, if and when their long-term memories were lost, they were lost very completely.

e) *Problem-Solving*

Early work by Allan (141, 145) using rather difficult logical problems throws some light on the process of "abstraction" which we have mentioned already as a question left open by studies using standard tests. Allan's subjects failed to abstract in the manner required by the instructions in the experiment, but the failure did not result from lack of power to make abstract points in writing or conversation but from inability to coordinate data. This type of difficulty has been shown clearly in a series of experiments by Clay (25, 26, 28), in which subjects of different ages were required to place counters on checkerboards to add up to given marginal totals, on rows or on colums or on both simultaneously. The problem for older people seemed not to lie in the arithmetic involved or in the initial task of producing some sort of solution by placing the counters, but to arise in making corrections for errors in this initial solution. Making a correction required the accumulation and holding of a considerable body of data for use simultaneously in a kind of "conceptual framework" in terms of which the correction needed could be identified. Older subjects seemed to find difficulty in holding the necessary quantity of data at any one time, frequently losing one piece of data while searching for another.

An experiment by Williams (148) suggests that, if senile patients can be assumed to represent an extreme form of normal old age, the difficulty found by older people in building conceptual frameworks is maximized if they have to deal with a large quantity of data all presented at one time. Williams found that senile patients were seldom able to find their way through pencil-and-paper mazes if these were presented complete at first showing but that they were usually able to do so if they were taken through a series of presentations in which the parts of the maze were added one by one.

f) *Motivation*

Clay's results (28) showed that older subjects frequently "gave up" trying at the more difficult problems. Their failure, however, appeared to be due not to lack of motivation but to inability to do the work. The first sign of difficulty with age was usually an increase of time taken while accuracy was held constant, but higher in the age scale this would give way to shorter performance time with failure to

correct errors or handing in an incomplete solution. However, although older subjects would give up the most difficult problems, they would persist with the simpler ones, which they would have been unlikely to do if their motivation had been low.

g) *Some Factors Common to Different Types of Performance*

One major source of lower performance by older people, which seems to run through many of the lines of results we have surveyed, is the partial failure of short-term retention. The importance of short-term storage of data in normal human behavior is rapidly becoming recognized. It is an essential factor in all integration of data over time, even in such elementary matters as listening to a connected sentence or in maintaining spatial orientation. It would indeed seem to be the key to so much normal human performance that any change of its capacity with age would inevitably have widespread effects. Several studies by Kay (64), Kirchner (145), Speakman (145), and Bromley (9) have shown severe impairment of short-term retention in normal old people if the material to be retained has to be carried over an intervening activity. This is true even when the ordinary digit span shows little change with age.

Just how intervening activity interferes with short-term memory is not certain, but it is tempting to postulate that it does so by producing neural noise or by lowering signal-to-noise ratio. Short-term memory traces must almost certainly be carried in some dynamic form, such as by self-regenerating neural circuits employing substantial numbers of neurons. Any reduction in the number of functional neurons —as is, for example, implied in the loss of brain weight with age—or increased randomness in the system, or other activity going on in the brain will tend to make these traces less viable.

The concept of neural noise as a cause of change in performance with age would indeed seem to be capable of explaining a wide range of experimental results. It does, for example, seem possible that different types of slowness and other impairment can be attributed to increase of "noise" in different parts of the neural mechanism. The pursuit of the possibilities opened up by this approach could well be the basis of a substantial program of research.

A third finding running through many different studies is that the relationships between age and performance are markedly nonlinear. They indicate in some cases that more than one factor is probably at work and that the changing performance is the result of the aging of several capacities at different rates. The picture is undoubtedly complicated because of compensation for impairment by changes of method and because falling capacity does not show if the demands of the task do not stretch it to its full extent. We have already mentioned that these findings sound a note of caution for correlational studies comparing several different performances from the same individuals. The successful achievement of compensation by older people also shows that the ability to plan the "strategy" of a complex performance and to adapt methods in the face of impairment declines at a later age than does speed, and probably holds up better than either muscular strength or capacity for retention. The variety and the nature of these nonlinearities, however, constitute a challenge to the analysis of performance which is likely to provide research work for many years to come.

3) EMPLOYMENT AND RETIREMENT

The topics of employment and retirement have understandably aroused a great deal of popular interest and generated a substantial literature based, to a varying extent, on factual information. We shall here deal almost entirely with original research contributions, but special mention may be made of the reports of two conferences, one in Sweden (57) and one in Germany (2), the former of which does in fact report a considerable amount of research data. In Britain, the Ministry of Labour and National Service has issued two reports from a committee set up to study the problems of the employment of older men and women (89, 90) and has also published a bibliography by Speakman of research on changes in working capacity with age (124). This summarizes the main sources of research data in the form of tables and graphs. A review of the general problems of older people at work has been made by Karsten (62) and of past research on industrial accidents by King and Speakman (72).

Figures for numbers employed in different age ranges are available from a variety of sources. For example, in Britain reference may be made to the *Ministry of Labour Gazette* and the publications of the Registrar General's department.

Especially useful are the very complete data from the one per cent sample tables of the Census. Some figures for France are given by Daric (31) and for Finland by Tunkelo (132, 133). Some other data are included in the proceedings of the World Population Conference held in 1954 (102). More elaborate figures for the British iron and steel industry have been given by Fleming (36).

As Fleming points out, figures of this kind are, on their own, of little use. A number of attempts have therefore been made to provide more refined treatments and to relate them to other data. A study by Koivisto (74), for example, has related the employment of older people to their attitude to work and their status in the eyes of their fellows, and a survey has been made by the Industrial Welfare Society (56) of numbers of older people employed in different types of work and also of the attitudes of employers to older work people. Studies of attitudes to aging and their industrial consequences are in progress at Liverpool (80). The majority of research in the field of employment, however, may be classed under three headings, which we shall consider in turn.

a) *Measures of Output by People in Different Age Ranges*

By far the most comprehensive study of this kind was made by Wackwitz (139) of employees at a Dutch electrical equipment factory, using production data obtained just before the second World War. The study dealt with output of skilled engineers, glass-blowers, and unskilled and semiskilled workers. The first of these groups showed an increase of output to about age forty-five, and the latter three groups a similar rise to about age thirty-five. After these ages, production showed a slow decrease, varying a little from one job to another, but in most cases small. Figures obtained for spoiled work from glass-blowers gave a similar picture—a decrease of spoiled work to the thirties, followed by some increase. It is impossible to do justice to Wackwitz's work in a brief compass, and it is regrettable that no English translation is available.

The main difficulty of using output figures in this way is that we cannot be sure how far they truly reflect the average ability of men and women at different ages and how far they have been distorted by progressive selection occurring in the course of labor turnover. In Clay's study (27), mentioned earlier, the labor turnover was small enough for the output figures to be reasonably reliable, but in others we may suspect that the fall of output with age might have been greater had many of the workers who left stayed on. A study specifically designed to investigate this point has been made by King (71). More evidence of the effects of progressive selection may perhaps be found in the decrease of variability amongst Wackwitz's older subjects—a result diametrically opposed to that found in practically all experimental studies.

b) *Age Distributions in Work of Different Types*

The objection just outlined can be overcome by comparing jobs making different demands in terms of the age distributions of those employed on them. If we can assume that those who find a job unsuitable or unattractive will tend to leave, the presence or the absence of older people can in many cases provide evidence regarding their capacity to meet the demands of the jobs concerned. Data of this kind obtained by Shooter and R. M. Belbin (6, 141, 145) from a number of manufacturing industries have indicated that the most severe demand is that of speed, especially when the operative is compelled to keep up with a conveyor belt or other machinery pacing his work. Shooter and Belbin found a striking fall in the numbers employed in this type of job between the middle forties and the middle fifties. The fall was particularly great when demands for speed were combined with the requirement of substantial bodily activity. The importance of speed as a limitation upon older people has also been indicated by King in studies of the age distributions of men working on different agricultural jobs (69).

The main difficulty about using age distributions in this way is that they may be affected by factors other than capacities changing with age. They may, for example, be influenced by the history of the jobs in the sense that, when an operation is started, it tends to be staffed with new intake. Thus, those operations which have been in existence only a few years tend to have a younger age distribution than those which have been long established.

Two studies may be mentioned in which special attempts were made to avoid such sources of error. One by Le Gros Clark and Dunne (23) uses the British Census data for the years

1921, 1931, and 1951. The authors examine the ratios of workers over 65 to those 35-64 years of age, and of those 55-64 to those 35-54, and the changes of age distributions in the successive Census returns, for 32 jobs. The other study is that by Murrell, Griew, and Tucker (88), who found that differences of age distribution between jobs in a number of engineering firms were consistent both between different firms and localities and also within the same firm over a number of years. These investigators are now attempting, by job analysis, to pinpoint the sources of difficulty in those jobs showing low age distributions, and they plan to try at a later stage to remove the difficulties by the application of ergonomic and work-study principles.

c) *Numbers Changing Jobs at Different Ages.*

The most rigorous method of relating jobs to capacity by data from industrial records is to study the proportion of people joining or leaving particular jobs or classes of job at different ages. Unfortunately, data of this kind are extremely difficult to obtain. Shooter and R. M. Belbin, however, were able to confirm their finding regarding speed and bodily movement, and a number of other studies have been made using this method, especially in relation to two problems: the effect of heavy work on older men and factors encouraging or discouraging retirement.

(i) *Heavy Work.*—The tendency for older people to be engaged on heavy work was noted as long ago as 1933 by Barkin (3). Confirmatory evidence has been obtained by Shooter and R. M. Belbin (141, 145), by the Industrial Welfare Society (56), and by Thomas and Osborne (129) that very substantial numbers of older people are engaged upon work which is at least moderately heavy. It should be noted that in all these cases the age distributions were compared on jobs graded for "heaviness" and were not taken from whole industries (it is a common fallacy to assume that work in "heavy" industry can be equated with "heavy" work). The tendency for older people to be engaged on heavy operations is surprising, but has been confirmed in a further study by R. M. Belbin (7), which analyzed the work done by a group who had to shift jobs at frequent intervals owing to the poisonous nature of the material they were handling. Belbin found the older people tended clearly to be doing the heaviest jobs.

Evidence of a very different kind comes, however, from the extremely careful study by Richardson (105) of men in two foundries and a coal mine. Richardson found a substantial tendency for men to move to lighter work, especially from the mid-fifties onwards. Similar evidence of shifts to lighter work has been reported by Pearson (100), who notes also a tendency for older people to move from shift work to day work. Her figures suggest somewhat earlier moves than do Richardson's, a substantial number having moved in the forties.

The resolution of the apparent conflict between these two types of evidence lies partly in the fact that the heaviest work among the jobs included in Belbin's study was lighter than most of the so-called lighter work to which Richardson's subjects moved. Partly, however, it would seem to be in the relation between heavy work and speed. The heavier jobs in Belbin's study were clearly slower than the lighter, and Richardson's subjects, when asked what they meant by "lighter" work frequently indicated that they meant work which could be done at their own pace. This might, of course, have meant little more than that, if the pace was not forced, they could do less and thus expend less energy, but, in view of what has already been said about the slowing of sensorimotor performance with age, the question needs to be raised whether a definition of "heaviness" purely in terms of physical effort is adequate. There would seem to be a need for detailed study of the sensorimotor requirements of a number of jobs combined with physiological measures of work performance.

Taking the present evidence as a whole, the conclusion is suggested that, while the most strenuous work is unsuitable for older people, they find a wide range of moderately heavy work less demanding than light work requiring a faster tempo of action. We may suppose, by analogy with the results of Jokl's study of athletes (60), that this is especially so with older people who are in good training by having done heavy work for a number of years. The whole question of heavy work in relation to age would, however, seem to need further study and definition.

(ii) *Retirement.*—An analysis of reasons given for retirement or continuing at work past minimum pension age is given in a report with very fully tabulated data by the British Ministry of Pensions and National Insurance (83). This survey was based on some 28,900 persons who became eligible for pensions during the months of September and October, 1953. Of reasons given for retirement, some 28 per cent were that it had been compelled by the employer, 25 per cent were attributed to illness, and a further 25 per cent to "ill health." Practically all the reasons for continuing were included in three categories: "financial need" (45 per cent), "feel fit enough" (25 per cent), and "prefer to work" (20 per cent). A more detailed study of older unemployed men has been carried out by Richardson (107), who found occupationally significant disabilities in more than half of them. Rather similar findings were obtained in a more detailed study by Pearson (100), using a postal questionnaire on 220 men employed by a Liverpool firm just before retirement. The results suggest that failing health is a potent factor in causing retirement. Confirmatory evidence that declines in health cause moves to less strenuous work has been given by Le Gros Clark in studies of men employed by the London Transport Commission on omnibuses and by the London County Council as building workers (18, 19, 20). Further data and indications of the same kind are given by Hobson (53) and also by Brown, McKeown and Whitfield (13). The last authors suggest that there is little reserve of men over the age of sixty-five who are both fit and willing to work. A study of the relation of health to work among railway-locomotive drivers is in progress at Edinburgh (42).

The difficulty with all these inquiries is that they have had to rely, at least in part, on stated reasons for retirement or continuing at work. It is well known that such reasons may be unreliable, not only because of deliberate falsification, but also because often men do not fully recognize the reasons for their decisions. Comments on this problem have been made by Richardson (105), who observed that a number of moves attributed to ill health were made on account of illnesses far too trivial to be the sole cause of the moves involved. He suggested that sickness is often the precipitating factor in a move, the main cause of which is strain resulting from changes of capacity with age often supplemented by family pressure. Doubts about the accuracy of statements in reply to verbal questions are also expressed by Pearson (100), who, in a follow-up study of those who had recently retired, found many who complained of shortage of money and said they wanted to work but did nothing to try to find jobs. It appeared that they had a number of unexpressed reservations relating, for example, to the fact that they were unwilling to face the difficulties, and perhaps loss of status, involved in taking a job with a firm where they were unknown.

Moves in later middle age and in old age seem commonly to be to work of a lower pay or status (21, 22, 24), although the new work may still be skilled and, even if not, may yield satisfaction, as has been shown in the experiment reported by Richardson of employing pensioners as delivery-van "boys" (106). A few firms have established special workshops, in which fuller use of the capabilities of old employees can be made than would be the case if they were given jobs such as that of janitor. One firm, for example, manufacturing bottle-filling machinery has used older employees for making spare parts for old-type machines. Other examples are mentioned by Daric (31).

Three other solutions of the problem of employing older people have hardly been explored at all. The first is that on which Murrell and his colleagues are working (87): discovering the factors which limit the performance of older people at jobs they find difficult, and modifying the job to bring it within their capacities. As the present writer has pointed out, knowledge of the changes in skilled performance that occur in old age, coupled with detailed consideration of jobs and of equipment for them, should make possible a substantial easing of many operations and render them more suitable for older people (142). This could be done not only by lessening physical burdens and demands for rapid manipulation, but also by giving attention to intellectual demands made by the displays and controls of equipment installed in the course of mechanization.

The second possible solution is that of training older people for new jobs in which at least moderate degrees of skill are involved. Undoubtedly there are difficulties in training older people by existing methods, and apparently little along this line is being done in

industry (121). It would seem important to devise new training methods more suited to the capabilities of older people, and in this connection the important pioneer work of Eunice Belbin (5) would seem to deserve following up. A study of "rigidity" and its relevance to occupational training is being made at Liverpool (80).

The third possibility, shortening the hours of work has been touched on by a number of writers but has not been the subject of much systematic study. The question of whether or not older people can support their former jobs for part time, when they cease to be able to do so whole time, is of considerable theoretical interest; for the finding of evidence that they could do so would bear upon our views of the nature of fatigue and its relation to age. The problem of fatigue in older people is a subject about which surprisingly little is known at the present time. We may note at this point that Richardson (108) found that about half the retired men in his sample were doing part-time work and were content in doing so. The rest did not appear to have adjusted well to retirement and tended to be discontented: they had very little in the way of true hobbies.

A further study of those recently retired is being made by Treanton (131).

d) *Some General Indications from Studies of Employment and Retirement*

Taking the evidence as a whole, it seems clear that several different demands may limit the performance of older people in industry and that some of these demands may become effective well before conventional retiring ages. It would seem that the critical ages vary with different demands. For example, if speed and heaviness are both adjusted for persons in their thirties, the former will cause men and women to change work sooner than the latter; thus, moves may be made from light, fast work to work which, in terms of physical effort, is actually heavier. No systematic relationships of the different factors which may possibly limit performance have yet been worked out, however, and this again is a seemingly worthwhile field for research in the future. Work towards this end is envisaged by Pacaud (96).

A hitherto neglected area of research is the detailed study of the method and manner of work in industry by people of different ages. The laboratory experimental studies outlined earlier give promise that this would have both theoretical as well as practical significance. Further indications in the same direction come from studies of accidents by Whitfield (147) among coal-miners and by King (70) among agricultural workers. Both find that the nature and circumstances of accidents give evidence of increased carefulness among older men combined with slowness in recognizing and avoiding hazards. A study of the type envisaged is shortly to be undertaken by Treanton (131) upon executives.

4) SOCIAL AND ECONOMIC PROBLEMS

a) *Social Problems*

The two great landmarks of recent years in the study of old age have been the report entitled *Old People* (112) from a committee set up by the Nuffield Foundation under the chairmanship of B. Seebohm Rowntree, and J. H. Sheldon's inquiry into the health of old people, *The Social Medicine of Old Age* (118). The first of these reports dealt with accommodations for old people and stressed the need for further housing, also for clubs and for inducements to continue at work as an aid to health and independence. Sheldon, in his remarkable and extremely human book, not only surveyed the state of old people in the strictly medical sense but also considered their mental condition, family and domestic structure, and the problems brought about for old people and their families by illness at home. Since their publication, these two reports have had a profound impact on the pattern of government and local welfare services in Britain and, indirectly, have gone a long way to mitigate some of the difficulties of older people which are often, as Sheldon noted, due to relatively trivial disabilities not very costly to remove.

Welfare services of Great Britain have been described by Hobson (52), James (59), and Keeling (67); those of Ireland, by O'Doherty (92); and those of Switzerland, by Roth (111). A number of other papers of interest in this connection are included in the reports of the third and fourth congresses of the International Association of Gerontology (93, 101), including a description by Blyth-Brooke (8) of a now well-known experiment on occupying old people in a sheltered workshop. A review of social policies for old age, especially as they affect Britain, is contained in a recently published book by Shenfield (120).

Turning again to factual surveys, questionnaire studies were made in Finland in 1950 and 1952, in which random samples from census registers were used to determine the state of old people living in their own and in community homes (84, 115). An intensive study of a small town is at present in progress in Holland, combining sociological and psychological data, and plans are being made for a similar rural study (85). Of the several surveys in Britain (e.g. 76, 95), we may mention especially that made in Sheffield on the health, nutrition, and condition of older people, in which actual medical examinations were made of older people in their homes (54), and that in Edinburgh on the need for welfare services (43).

Sheldon (118) emphasized the importance of the help that older people obtained from their families and neighbors and the loneliness that might result when this was lacking. He re-emphasized these points in the first F. E. Williams lecture before the Royal College of Physicians in 1949 (119). The problem of social structure in working class communities as it affects older people, which was raised by Sheldon, has been noted also by Pearson (100), who observed that family ties were very much stronger than those of neighborhood, friendship, interest, or common employment. An important study in this field is an intensive investigation by Townsend (130) of family relationships in an East London borough. He has found that a surprisingly high portion (45 per cent) of old people share houses with relatives other than husband or wife and that many more have substantial numbers of relatives in the same or nearby streets. A great deal of help is given to old people in their homes, especially by daughters, and considerable return help is forthcoming by the old people in cooking and minding children. Townsend points out that these "three-generation" families have tended to isolate husbands from their wives but that any disruption would enormously increase demands upon welfare services for old people. He suggests that it is desirable to recognize these families by making suitable housing arrangements and providing help for the younger people who are hard pressed by having to look after older relatives needing continual care, and to encourage as much independence of old people within the family framework as possible.

### b) *Economic Circumstances*

The problems studied in these surveys have obvious economic aspects. While it is not our purpose here to consider these in detail, we may mention an incisive study of the problems of pension schemes and their cost contained in the *Report of the Committee on the Economic and Financial Problems of the Provision for Old Age* (104). While essentially referring to Great Britain, most of the treatment of this report is significant for all industrialized countries.

Pension legislation in Finland is described by Noponen (91). More detailed studies of the expenditure by old people have either been recently completed or are in progress in Germany (101) and Britain (1, 29, 77, 134).

### c) *The Present Status of Social Research on Aging in Europe*

The difficulty that attaches to many studies of social problems—having to rely largely on answers to verbal questions—applies to some but not all of those which have been outlined here. In several cases it has been possible to supplement answers to questions with more objective measures. Some serious difficulty about the reliability of verbal answers does, however, remain. Older people are not always very articulate about their needs, hopes, fears, and failings. In cases where income and expenditure have to be discussed, they may, indeed, be anxious to avoid conveying a true impression for fear of having to pay increased taxes or having welfare payments reduced. It thus becomes a matter of extreme difficulty to obtain reliable data by interview unless questions are asked by one who is known and trusted. The shift discernible from the large impersonal surveys to the smaller more intimate studies would seem, from this point of view, a step in the right direction. It would, however, seem worthwhile to explore means of obtaining information through persons genuinely interested in old people and prepared to spend a considerable amount of time getting to know them and ministering to their welfare.

Present social research on aging in Europe seems to have reached a point at which substantial and valuable factual information has been obtained, and it is beginning to be possible to probe beneath the bare surface facts. Areas have already been identified in which practical action is needed and measures have

been suggested which are likely to relieve some of the worst difficulties of older people. The results of any action taken need, however, to be carefully followed up; if resources and interest can be made available for this, the social investigations would seem to be capable of yielding insight into the "mechanisms" of individual and social relationships. If this were achieved soon, it would mean that gerontology would have an important contribution to make in the general development of social studies, similar to that which it is already making to many other branches of scientific research.

## BIBLIOGRAPHY AND REFERENCES


1. Abel-Smith, H. The cost of the support of the aged. In *Proc. Fourth Congr. Int. Ass. Geront.*, 1957 (to be published).
2. Arbeitswissenschaftlicher Kongress, Dortmund, 1955. Der ältere Mensch in der Arbeit und im Betrieb. *Ges. f. ArbWiss. Forsch. c V.*
3. Barkin, S. *The Older Worker in Industry.* New York Legislative State Document No. 60. Albany: Lyon, 1933.
4. Belbin, Eunice. The effects of propaganda on recall, recognition and behaviour. II. The conditions which determine the response to propaganda. *Brit. J. Psychol.*, 1956, **47**, 259-270.
5. Belbin, Eunice. Methods of training the older worker. *Ergonomics*, 1958, **1** (to be published).
6. Belbin, R. M. Difficulties of older people in industry. *Occup. Psychol.*, 1953, **27**, 177-190.
7. Belbin, R. M. Older men and heavy work. *Brit. J. industr. Med.*, 1955, **12**, 309-319.
8. Blyth Brooke, C. O. S. Sheltered workshop in a London borough. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: E. & S. Livingstone, 1955.
9. Bromley, D. B. Dep. Psychol., Univer., Liverpool, England. Personal Communication. 1957.
10. Bromley, D. B. Primitive forms of response to the matrices test. *J. ment. Sci.*, 1953, **99**, 374-393.
11. Bromley, D. B. Some experimental tests of the effect of age on creative intellectual output. *J. Geront.*, 1956, **11**, 74-82.
12. Brown, Ruth A. Age and paced work. *Occup. Psychol.*, 1957, **31**, 11-20.
13. Brown, R. G., McKeown, T., & Whitfield, A. G. W. Medical fitness in relation to employment of men aged 60-69. In *Proc. Fourth Congr. Int. Ass. Geront.*, 1957 (to be published).
14. Cesa-Bianchi, M. Ricerche sull'attivita psichica nell'età senile. *Acta Geront.*, 1951, **1**, 4-6.
15. Cesa-Bianchi, M. L'applicazione dei reattivi mentali nello studio dell'invecchiamento. *Arch. Psicol. Neurol. Psichiat.*, 1951, **12**, 390-393.
16. Cesa-Bianchi, M. Il reattivo Wechsler-Bellevue applicato all'età involutiva. *Contr. Lab. Psicol. dell' Univer. Cattol. S. Cuore*, 1952, **41**, 140-145.
17. Cesa-Bianchi, M. Contributi allo-studio delle modificacione psichiche in rapporto con l'età. *Contr. Lab. Piscol., dell' Univer. Cattol. S. Cuore.*, 1955, **49**, 1-61.
18. Clark, F. Le Gros. *A Study of 320 Ageing Maintenance Workers.* First report on the later working life in the building industry. London: Nuffield Found., 1954.
19. Clark, F. Le Gros. *The Working Fitness of Older Men.* Second report on the later working life in the building industry. London: Nuffield Found., 1954.
20. Clark, F. Le Gros. *Ageing Men in the Labour Force.* Third report on the later working life in the building industry. London: Nuffield Found., 1955.
21. Clark, F. Le Gros. *The employment problems of elderly men.* Second report on alternative work in later life. London: Nuffield Found., 1956.
22. Clark, F. Le Gros. *Bus workers in their later lives.* London: Nuffield Found., 1957.
23. Clark, F. Le Gros, & Dunne, Agnes C. *Ageing in Industry.* London: Nuffield Found., 1955.
24. Clark, F. Le Gros, & Dunne, Agnes C. *New Jobs for Old Workers.* First report on alternative work in later life. London: Nuffield Found., 1955.
25. Clay, Hilary M. Changes of performance with age on similar tasks of varying complexity. *Brit. J. Psychol.*, 1954, **45**, 7-13.
26. Clay, Hilary M. An age difficulty in separating spatially contiguous data. *J. Geront.*, 1956, **11**, 318-322.
27. Clay, Hilary M. A study of performance in relation to age at two printing works. *J. Geront.*, 1956, **11**, 417-424.
28. Clay, Hilary M. The relationship between time, accuracy and age on similar tasks of varying complexity. *Gerontologia*, 1957, **1**, 41-49.
29. Cole, Dorothy, & Utting, J. E. G. Estimating expenditure, saving and income from household budgets. *J. R. Statist. Soc. (A)*, 1956, **119**, 371-386.
30. Crossman, E. R. F. W., & Szafran, J. Changes with age in the speed of information intake and discrimination. *Experientia Supplementum IV. Symposium on Experimental Gerontology.* Basel: Birkhäuser Verlag, 1956. Pp. 128-135.
31. Daric, J. Survey of the employment of elderly workers in France. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: E. & S. Livingstone, 1955.
32. Eysenck, M. D. A study of certain qualitative aspects of problem solving behaviour in senile dementia patients. *J. ment. Sci.*, 1945, **91**, 337-345.
33. Eysenck, M. D. An exploratory study of mental organisation in senility. *J. Neurol. Neurosurg. and Psychiat.*, 1945, **8**, 15-22.
34. Fieandt, K. von, *et al.* Personal tempo and phenomenal time at different age levels. *Reports from Psychological Institute, Univer. Helsinki*, 1956, No. 2.
35. Fieandt, K. von. Personal tempo and phenomenal time at different age levels. *Geron*, 1956-1957, **8-9**, 85-101.

36. Fleming, C. Age-composition of the British iron and steel industry. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: E. & S. Livingstone, 1955.
37. Foulds, G. A. Variations in the intellectual activities of adults. *Amer. J. Psychol.*, 1949, **62,** 238-246.
38. Foulds, G. A., & Raven, J. C. Normal changes in the mental abilities of adults as age advances. *J. ment. Sci.*, 1948, **94,** 133-142.
39. Galton, F. On the Anthropometric Laboratory at the late International Health Exhibition. *J. Anthrop. Inst.*, 1885, **14,** 205-218.
40. Galton, F. On instruments for (1) testing perception of differences of time and for (2) determining reaction time. *J. Anthrop. Inst.*, 1889, **19,** 27-29.
41. Gemelli, A., & Cesa-Bianchi, M. Disadattamento del vecchio alla vita individuale, familiare e sociale. *Atti. del II° Congr. Naz. di Gerontol. e Geriatria*, 1952.
42. Gordon, C. Dep. Publ. Hlth and Soc. Med., Univer. Edinburgh. Personal communication. 1957.
43. Gordon, C., *et al.* Domiciliary services for over sixties. *Med. Officer*, 1957, **98,** 19-24, 35-44.
44. Gregory, R. L. A note on summation time of the eye indicated by signal/noise discrimination. *Quart. J. exp. Psychol.*, 1955, **7,** 147.
45. Gregory, R. L. An experimental treatment of vision as an information source and noisy channel. In C. Cherry (Ed.), *Information Theory: 3rd London Symposium 1955*. London: Methuen, 1956.
46. Gregory, R. L., & Cane, Violet. A statistical information theory of visual thresholds. *Nature*, 1955, **176,** 1272.
47. Griew, S. Unit for Research on Employment of Older Workers. Dep. Psychol., Univer. Bristol. Personal communication. 1957.
48. Halstead, H. J. A psychometric study of senility. *J. ment. Sci.*, 1943, **89,** 363-373.
49. Halstead, H. J. Mental tests in senile dementia. *J. ment. Sci.*, 1944, **90,** 720-726.
50. Heim, A. W., & Wallace, J. G. The effects of repeatedly re-testing the same group on the same intelligence test. Part I. Normal adults. *Quart. J. exp. Psychol.*, 1949, **1,** 151-159.
51. Heim, A. W., & Wallace J. G. The effects of repeatedly re-testing the same group on the same intelligence test. Part II. High grade mental defectives. *Quart. J. exp. Psychol.*, 1950, **2,** 19-32.
52. Hobson, W. General problems of ageing. In *Modern Trends in Geriatrics*. London: Butterworth, 1956.
53. Hobson, W. Employment, retirement and health. In *Modern Trends in Geriatrics*. London: Butterworth, 1956.
54. Hobson, W., & Pemberton, J. *The Health of the Elderly at Home*. London: Butterworth, 1955.
55. Hopkins, B., & Post, F. The significance of abstract and concrete behaviour in elderly psychiatric patients and control subjects. *J. ment. Sci.*, 1955, **101,** 841-850.
56. Industrial Welfare Society. *The Employment of Elderly Workers*. Report of a survey on the practice and experience of 400 member firms. London: The Society, 1950.
57. Industriens Utredningsinstitut. *Industrien och fur gubbningen*. Uppsala: Almqvist & Wiksells, 1955.
58. Inglis, J., Shapiro, N. B., & Post, F. "Memory function" in psychiatric patients over sixty, the role of memory in tests discriminating between "functional" and "organic" groups. *J. ment. Sci.*, 1956, **102,** 589-598.
59. James, Bertha. The part played by voluntary organisations in welfare work for the aged in England. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: E. & S. Livingstone, 1955.
60. Jokl, E. *Alter und Leistung*. Berlin: Springer-Verlag, 1954.
61. Jones, H. E., & Conrad, H. S. The growth and decline of intelligence. *Genet. Psychol. Monogr.*, 1935, **13,** 223-298.
62. Karsten, Anitra. Age and work-potential. *Geron*, 1952-53, **4-5,** 69-80.
63. Kay, H. Learning of a serial task by different age groups. *Quart. J. exp. Psychol.*, 1951, **3,** 166-183.
64. Kay, H. Experimental studies of adult learning. Unpublished thesis, Cambridge Univer. Library, 1953.
65. Kay, H. The effects of position in a display upon problem solving. *Quart. J. exp. Psychol.*, 1954, **6,** 155-169.
66. Kay, H. Some experiments on adult learning. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: E. & S. Livingstone, 1955.
67. Keeling, Dorothy C. Advisory services for old people in the United Kingdom. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: E. & S. Livingstone, 1955.
68. Kelly, J., & Pinkerton, P. An attempted correlation between clinical and psychometric findings in senile arteriosclerotic dementia. *J. ment. Sci.*, 1952, **98,** 244-255.
69. King, H. F. Age and work in agriculture. Unpublished thesis, Cambridge Univer. Library, 1953.
70. King, H. F. An age-analysis of some agricultural accidents. *Occup. Psychol.*, 1955, **29,** 245-253.
71. King, H. F. An attempt to use production data in the study of age and performance. *J. Geront.*, 1956, **11,** 410-416.
72. King, H. F., & Speakman, D. Age and industrial accident rates. *Brit. J. industr. Med.*, 1953, **10,** 51-58.
73. Koga, T., & Morant, G. M. On the degree of association between reaction times in the case of different senses. *Biometrika*, 1923, **14,** 346-372.
74. Koivisto, T. The effect of high age on the status of the industrial worker at the work site. *Geron*, 1952-53, **4-5,** 105-123.
75. Leonard, J. A. Some experiments on the temporal relation between information and action. Unpublished thesis, Cambridge Univer. Library, 1952.
76. Liverpool Personal Service Society and the University of Liverpool Department of Social Science. *Social Contacts in Old Age*. Liverpool: Liverpool Univer. Press, 1953.
77. Lydall, H. F. *British Incomes and Saving*. Oxford: Blackwell, 1955.

78. McAdam, W., & McClatchey, W. T. The electroencephalogram in aged patients of a mental hospital. *J. ment. Sci.*, 1952, **98,** 711-715.
79. McAdam, W., & Robinson, R. A. Senile intellectual deterioration and electroencephalogram—a quantitative correlation. *J. ment. Sci.*, 1956, **102,** 819-825.
80. Medical Research Council Group for Research on Occupational Aspects of Ageing; A. Heron (deputy director). Dep. Psychol., Univer. Liverpool, England. Personal communication. 1957.
81. Miles, W. R. Measures of certain human abilities throughout the life span. *Proc. Nat. Acad. Sci.*, 1931, **17,** 627-633.
82. Miles, C. C., & Miles, W. R. The correlation of intelligence scores and chronological age from early to late maturity. *Amer. J. Psychol.*, 1932, **44,** 44-78.
83. Ministry of Pensions and National Insurance. *Reasons Given for Retiring or Continuing at Work.* London: H. M. Stationery Office, 1954.
84. Modeen, G. Modern research methods used in investigations into the conditions of the aged. *Geron*, 1952-53, **4-5,** 27-37.
85. Munnichs, J. M. A. Gemeenschappelijk Institut voor Toegepaste Psychologie, Nijmegen, Holland. Personal communication. 1957.
86. Munnichs, J. M. A. Het verschil in handelingswijze van bejaarden en volwarsenen. I and II. *T. v. d. Psychol. Kring, a Nijmeegse Universiteit*, 1956, **4,** 143-147, 170-181.
87. Murrell, K. F. H. Unit for Research on Employment of Older Workers. Dept. Psychol., Univer. Bristol, England. Personal communication. 1957.
88. Murrell, K. F. H., Griew, S., & Tucker, W. A. Age structure in the engineering industry: a preliminary study. *Occup. Psychol.*, 1957, **31,** 150-168.
89. National Advisory Committee on the Employment of Older Men and Women. *First Report.* London: H. M. Stationery Office, 1953.
90. National Advisory Committee on the Employment of Older Men and Women. *Second Report.* London: H. M. Stationery Office, 1955.
91. Noponen, A. The National Pensions Old Age Assistance Acts. *Geron*, 1952-53, **4-5,** 17-26.
92. O'Doherty, B. Geriatrics, economics and public health—a common problem. *Irish J. med. Sci.*, May, 1957, 213-226.
93. *Old Age in the Modern World.* Report of the Third Congress of the International Association of Gerontology, London, 1954. Edinburgh: E. & S. Livingstone, 1955.
94. Orme, J. E. Intellectual and Rorschach test performances of a group of senile patients and of a group of elderly depressives. *J. ment. Sci.*, 1955, **101,** 863-870.
95. *Over Seventy: Report of an Investigation into the Social and Economic Circumstances of One Hundred People over Seventy Years of Age.* National Council of Social Service, London, 1954.
96. Pacaud, S. Centre Nationale de la Recherche Scientifique, Paris. Personal communication. 1957.
97. Pacaud, S. Le vieillisement des aptitudes déclin des aptitudes en fonction de l'âge et du niveau d'instruction. *Biotypologie*, 1953, **14,** 65-94.
98. Pacaud, S. Experimental research on the ageing of psychological functions. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: E. & S. Livingstone, 1955.
99. Pacaud, S. Le vieillissement des aptitudes. In L. Binet and Fr. Bourlière (Eds.), *Précis de Gerontologie.* Paris: Masson & Cie, 1955.
100. Pearson, Margaret. The transition from work to retirement. *Occup. Psychol.*, 1957, **31,** 80-88, 139-149.
101. *Proceedings of the Fourth Congress of the International Association of Gerontology, Merano, Italy, 1957* (to be published).
102. *Proceedings of the World Population Conference, Rome*, 1954. New York: United Nations Department of Economic and Social Affairs, 1955.
103. Raven, J. C. The comparative assessment of intellectual ability. *Brit. J. Psychol.*, 1948, **39,** 12-19.
104. *Report of the Committee on the Economic and Financial Problems of the Provision for Old Age.* London: H. M. Stationery Office, 1954.
105. Richardson, I. M. Age and work: a study of 489 men in heavy industry. *Brit. J. industr. Med.*, 1953, **10,** 269-284.
106. Richardson, I. M. Renewing their youth: a successful experiment in the employment of pensioners. *Trans. Ass. industr. Med. Off.*, 1953, **3,** 227-229.
107. Richardson, I. M. A socio-medical study of 200 unemployed men *Med. Officer*, 1956, **96,** 165-170.
108. Richardson, I. M. Retirement: a socio-medical study of 244 men. *Scot. med. J.*, 1956, **1,** 381-391.
109. Riegel, K. Psychologisches Institut der Universität Hamburg, Germany. Personal communication. 1957.
110. Robinson, R. A. The correlation between EEG abnormality and senile arteriosclerotic organic deterioration. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: E. & S. Livingstone, 1955.
111. Roth, J. Alte Verpflichtungen und neue Aufgaben der Schweizerischen Stiftung "Für das Alter." *Z.f. Präventivmed.*, 1957.
112. Rowntree, B. S. *Old People: Report of a Survey Committee on the Problems of Ageing and the Care of Old People.* London: Oxford Univer. Pr., 1947.
113. Ruch, F. L. The differentiative effects of age upon human learning. *J. gen. Psychol.*, 1934, **11,** 261-286.
114. Ruger, H. A., & Stoessiger, B. Growth curves of certain characteristics in men. *Ann. Eugen.*, 1927, **2,** 76-111.
115. Salomaa, N. On the conditions of the aged in Finland: a committee study. *Geron.* 1952-53, **4-5,** 38-47.
116. Shapiro, N. B., Field, J., & Post, F. An enquiry into the determinants of a differentiation between elderly "organic" and "non-organic" psychiatric patients on the Bender Gestalt Test. *J. ment. Sci.*, 1957, **103,** 364-374.
117. Shapiro, N. B., *et al.* "Memory function" in psychiatric patients over sixty: some methodological and diagnostic implications. *J. ment. Sci.*, 1956, **102,** 233-246.

118. Sheldon, J. H. *The Social Medicine of Old Age.* London: Oxford Univer. Pr. for the Nuffield Found., 1948.
119. Sheldon, J. H. The aged in modern society. *Brit. med. J.*, 1950, **1,** 319-323.
120. Shenfield, Barbara E. *Social Policies for Old Age.* London: Routledge, & Kegan Paul, 1957.
121. Shooter, A. M. N., *et al.* Some field data on the training of older people. *Occup. Psychol.*, 1956, **30,** 204-215.
122. Singleton, W. T. Age and performance timing on simple skills. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: E. & S. Livingstone, 1955.
123. Singleton, W. T. The change of movement timing with age. *Brit. J. Psychol.*, 1954, **45,** 166-172.
124. Speakman, D. *Bibliography of Research on Changes in Working Capacity with Age.* London: Ministry of Labour and National Service, 1956.
125. Speakman, D. The effect of age on the incidental re-learning of stamp values: the use of deduction in a subsidiary test. *J. Geront.*, 1954, **9,** 162-167.
126. Szafran, J. Changes with age and with exclusion of vision in performance at an aiming task. *Quart. J. exp. Psychol.*, 1951, **3,** 111-118.
127. Szafran, J. Some experiments on motor performance in relation to ageing. Unpublished thesis, Cambridge Univer. Library, 1953.
128. Szafran, J. Experiments on the greater use of vision by older people. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: E. & S. Livingstone, 1955.
129. Thomas, G., & Osborne, B. *Older people and their employment.* Social Survey Report No. 150. London: Central Office of Information, 1950.
130. Townsend, P. *Family Life of Old People.* London: Routledge & Kegan Paul, 1957.
131. Treanton, J. R. Institut des Sciences Sociales du Travail, Univer. Paris. Personal communication. 1957.
132. Tunkelo, A. The distribution of aged persons in Finland. *Geron,* 1956-57, **8-9,** 10-12.
133. Tunkelo, A. Occupations of the different age groups in Finland. *Geron,* 1956-57, **8-9,** 54-60.
134. Utting, J. E. G., & Cole, Dorothy. Sampling for social accounts—some aspects of the Cambridgeshire survey. *Bull. int. Statist. Inst.*, 1954, **34,** 351-378.
135. Verhage, F. Psychologisch Institut "Heymens" der Rijk-Universiteit te Groningen, Holland. Personal communication. 1957.
136. Verville, E., & Cameron, N. Age and sex differences in the perception of incomplete pictures by adults. *J. genet. Psychol.*, 1946, **68,** 149-157.
137. Verzar-McDougall, J. Studies in learning and memory in ageing rats. *Gerontologia,* 1957, **1,** 65-85.
138. Vincent, D. F. The linear relationship between age and score of adults in intelligence tests. *Occup. Psychol.*, 1952, **26,** 243-249.
139. Wackwitz, J. D. *Het verband tusschen arbeidsprestatie en leeftijd.* Deflt: Waltman, 1946.
140. Wallace, Jean G. Some studies of perception in relation to age. *Brit. J. Pyschol.*, 1956, **47,** 283-297.
141. Welford, A. T. *Skill and Age: An Experimental Approach.* London: Oxford Univer. Pr. for the Nuffield Found., 1951.
142. Welford, A. T. Extending the employment of older people. *Brit. med. J.*, 1953, **2,** 1193-1197.
143. Welford, A. T. Age and Learning: Theory and Needed Research. *Experientia Supplementum IV. Symposium on Experimental Gerontology.* Basel: Birkhäuser Verlag, 1956. Pp. 136-143.
144. Welford, A. T. Methodological problems in the study of changes in human performance with age. In Wolstenholme, G. E. W., & O'Connor, Cecelia M. (Eds.), *Ciba Foundation Colloquia on Ageing,* Vol. 3. London: Churchill, 1957. Pp. 149-169.
145. Welford, A. T. *Ageing and Human Skill.* London: Oxford Univer. Pr. for the Nuffield Found., 1958.
146. Weston, H. C. On age and illumination in relation to visual performance. *Trans. Illum. Eng. Soc.*, 1949, **14,** 281-297.
147. Whitfield, J. W. Individual differences in accident susceptibility among coal miners. *Brit. J. industr. Med.*, 1954, **11,** 126-139.
148. Williams, M. Spatial disorientation in senile dementia. *J. ment. Sci.*, 1956, **102,** 291-299.
149. Wright, J. M. von. *An Experimental Study of Human Serial Learning.* København: Ejnar Munksgaards Forlag.
150. Zonneveld, R. J. van. *Health Problems of the Aged.* Essen: van Gorcum, 1957.

# PUBLIC HEALTH AND THE AGED IN EUROPE: RESEARCH AND PROGRAMS

R. J. VAN ZONNEVELD, M.D.

*(From the Section of Gerontology, National Health Research Council T.N.O., Netherlands Foundation for Applied Scientific Research)*

Gerontology is a multidisciplinary science. The problems of aging have so many aspects that investigators of widely divergent interests find important fields for research. In one of these fields the accent lies on the health of the whole population of the aged. This aspect of gerontological research cannot be omitted when dealing with the implications of an aging population. The knowledge collected by researchers in the natural and social sciences forms only a partial basis for sociomedical studies. Such studies are necessary, however, to get an insight into the health status of aging and aged persons and into the measures to be taken to maintain or improve this status.

The definition, then, of the public health aspect of gerontological research is rather vague. Sometimes the clinical aspects of health and disease come much to the foreground, sometimes the social aspect. This will influence the following survey of public health research with respect to the elderly and the aged in Europe.

In most countries in Western Europe more than 10 per cent of the population is at least 65 years old. It appears likely that this percentage will increase in the next 25 years. A general awareness of the problems attendant upon the increase in the number of old persons has arisen since World War II. Recently a number of investigations have been focused upon measuring the consequences of this increase. Many of these researches concentrate on the public health implications. While both the research and the practical problems are still in an early stage of development, some general trends are apparent.

Few sociomedical surveys on the state of health of the aged had taken place before Sheldon started his investigations in 1945 in Great Britain. Since then a growing number of surveys, and surveys of more extensive nature have been carried out in various countries. While Sheldon investigated 467 aged persons in one town, later surveys extended over several thousand persons or whole countries. Qualitatively, more reliable results have been obtained either by involving investigators who could judge the situations encountered or by actually examining the aged rather than interrogating them.

The more recent surveys have disadvantages as well. Extensive surveys require many investigators. Subjective analysis, which is often required, leads to lowered reliability of some of the findings. There is the ever present danger of superficiality in researches with many subjects, and it is well to remember that comprehensive case studies employing few subjects are also necessary.

The review deals with sociomedical surveys and social inquiries of the aged (the latter investigations only insofar as they are concerned with health) of both general and specific character, which have been carried out on a nationwide, a regional, or a local scale. Reviewed here are studies made by medically trained investigators and by lay people, in which both interviews and medical examinations were used. Examples of all these kinds of inquiries have been given to illustrate that in many countries in Europe there is a need to know more of the public health aspect of an aging population and to launch or to improve medical provisions on its behalf. Some of the methods and results of these surveys are thought to be important. At the same time consideration is given to questions regarding the desirability of one-man surveys, the eventual necessity of expert medical examinations and of actual evaluations of the health conditions encountered, and the sufficiency of local or regional investigations.

A number of inquiries regarding the aged who have been admitted, or have asked for admission to institutions are mentioned in this review, as well as some surveys of special groups (such as the chronically ill) and some

ACKNOWLEDGEMENTS: I am very grateful to the Gerontological Society, Inc., for having invited me to present a report on the public health aspects of gerontology in Europe. I wish to thank the National Health Research T.N.O., The Hague, for its willingness to offer me the opportunity to accept the invitation.

The material for this review, which should not be considered exhaustive (a number of requests for information remained unanswered,) has come partly from many persons in Europe. To all those—medical, sociomedical, and social gerontological investigators, public health and social welfare administrators, geriatricians, officers of voluntary organizations for the care of the aged, and others—who helped me so much by providing me with the relevant information and literature, I am much indebted.

inquiries on public health aspects of certain syndromes in the aged. The findings of these surveys are useful, but they are only a beginning. The same applies to surveys on the relationships between retirement and state of health, migration and health conditions of the aged, etc.

Some information on the health services in various countries of Europe may be useful at this point. Every country has a public health service, but these services vary from one country to another. There are countries with a Ministry of Health (Great Britain); other countries have combined ministries (as the Ministry of Public Health and Family in Belgium, or the Ministry of Social Affairs and Public Health in The Netherlands). All these countries have other agencies of importance, such as ministries of social welfare. In The Netherlands the Ministry of Social Welfare is also interested in the health status of the aged, and it conducts surveys on the social circumstances of this group, in which sociomedical data are also included. The Ministry of Housing and Building Industry is also concerned with the problems of the aged, as it has to provide suitable housing. Another point of importance is the role of voluntary agencies. In Eastern Europe these are nonexistent. In some countries they play a minor role, as in Scandinavia. In other countries, The Netherlands, for example, they greatly influence all public health programs.

The previously noted increase in the number of old people in Western Europe is a result of a number of factors. The postwar rise in birth rates has, for the most part, subsided, although in some countries the birth rate is still above that of prewar years. Medical and social progress has led to a lengthening of the mean life expectancy at birth. For instance, male babies born in one of the years 1953-1955 in The Netherlands had a life expectancy of 71 years, and female babies of 73.9 years. In the period 1870-1879, the expectancies were 38.4 for males and 40.7 years for females. Life expectancy at the age of 60 has increased 30 per cent, although the absolute gain in years is not as spectacular as that for the newborn. From 1870-1879 in The Netherlands, a man of 60 could expect to live 13.3 years, and a woman 14.1 years. By 1953-1955, these figures had increased to 17.8 years for men and 18.9 for women. This phenomenon is by no means restricted to The Netherlands. Another factor affecting the percentage of old people in the population is the steady emigration of younger persons from West Europe to overseas countries.

This absolute and relative increase in the number of older people (Table 1) is expected to continue in the coming decades. In Norway, for instance, in 1950 there were 316,000 per-

TABLE 1. ABSOLUTE NUMBERS OF PERSONS AGED 65–74 YEARS AND 75 YEARS AND OVER, PERCENTAGES OF AGED PERSONS IN THE TOTAL POPULATION, MORTALITY AND PERCENTAGE OF MORTALITY OF PERSONS 65 YEARS AND OVER OF THE TOTAL MORTALITY IN VARIOUS EUROPEAN COUNTRIES.

(Derived from vital statistics of World Health Organization)

| Country | Year | Number of Persons (In Thousands) | | Per Cent Over 65 | Mortality Per Cent | Per Cent Mortality 65 and Over of Total Mortality |
|---|---|---|---|---|---|---|
| | | 65–74 | 75 and Over | | | |
| Austria | Estim. July, 1953 | 525 | 238 | 10.9 | 12.0 | 62 |
| Belgium | Estim. July, 1953 | 661 | 337 | 11.4 | 12.1 | 63 |
| Denmark | Estim. July, 1953 | 278 | 135 | 9.5 | 9.0 | 65 |
| Finland | Mean Estim., 1953 | 198 | 84 | 6.8 | 9.6 | 53 |
| France | Census May, 1954 | 3,298 | 1,838 | 12.0 | 13.0 | 64 |
| Germany (Fed. Rep.) | Mean Estim., 1953 | 3,270 | 1,470 | 9.6 | 11.0 | 62 |
| Greece | Census May, 1951 | 347 | 163 | 6.7 | ..... | ..... |
| Italy | Census May, 1951 | 2,613 | 1,190 | 8.1 | 10.0 | 58 |
| The Netherlands | Mean Estim., 1953 | 575 | 279 | 8.1 | 7.7 | 62 |
| Norway | Mean Estim., 1953 | 198 | 124 | 9.6 | 8.5 | 67 |
| Portugal | Estim. July, 1953 | 418 | 194 | 7.1 | 11.3 | 43 |
| Spain | According to Gil, 1952 | 2,050* | ..... | 7.2 | 10.6 | ..... |
| Sweden | Mean Estim., 1953 | 504 | 258 | 10.6 | 9.7 | 70 |
| Switzerland | Mean Estim., 1953 | 320 | 92 | 8.4 | 10.2 | 63 |
| United Kingdom (England, Wales, Scotland) | Estim. July, 1953 | 3,647 | 1,845 | 11.2 | 11.4 | 66 |
| Yugoslavia | Census Jan., 1954 | ..... | 284 | 4.2 | 12.4 | 35 |

* Includes all persons of 65 and over.

sons over sixty-five years of age. In 1970, there are expected to be 504,000. This is an increase of 60 per cent, and Norway is not to be regarded as an isolated case. The vital statistics of almost all the European countries show a decrease in the mortality rates for all age groups.

In most countries in Europe, most people live until after the age of sixty-five. The better the health and social conditions, the greater the number of people who reach advanced ages.

The principal causes of death in Western Europe are, therefore, those prevalent in the elderly. They are arteriosclerotic and degenerative heart disease (B 26 of the abbreviated International List of Diseases and Causes of Death, adopted 1948), malignant neoplasms, including neoplasms of lymphatic and haematopoietic tissues (B 18), and vascular lesions affecting the central nervous system (B 22).

It is especially interesting to note how many old people die of "Senility without mention of psychosis, ill defined and unknown causes" (B 45) in Portugal and France as compared with Switzerland, England and Wales, and Denmark. It seems that the higher the standard of medical science and the better the facilities for making accurate diagnoses, the fewer the persons for whom this cause of death is certified. In the Federal Republic of Germany, B 45 is the second principal cause of death in men of 80-84 years and in both sexes at 85 and over. In Portugal, however, "senility" is the third principal cause of death for women 65-70 years old, second for men of 65-70 and for women of 70-74 years, first for men of 70-74, and first for both sexes of 75 years and over. In the Federal Republic of Germany B 45 is listed as the cause of death in 24 per cent of deaths of persons after their eighty-fifth year, while in Portugal 53 per cent of the deaths of all persons of 80 years and over are certified as B 45.

Comparative statistical studies in The Netherlands for the years 1921-1923 and 1951-1953 (Table 2) show in the 60-79 age group a marked increase in the group of cardiovascular diseases and in diseases of the nervous system, a decrease in respiratory diseases, in urogenital diseases, and in "senility." For the ages 80 and older, a very marked decrease in senility, a decrease in respiratory diseases, a very marked increase in cardiovascular diseases, and an increase of nervous diseases can be observed.

## PART I. RESEARCH

### 1. *General Health Surveys*

Few general investigations into the health status of the aged have been carried out. In many countries the responsible authorities are well aware of the rapidly increasing number of aged people and the impact of this increase on the health services. However, data of a national character on the health situation of

TABLE 2. DEATHS, BY GROUPS OF CAUSES OF DEATHS AND BY AGE, PER 100 DECEASED PERSONS IN EACH AGE GROUP DURING THE PERIODS 1921–1923 AND 1951–1953 IN THE NETHERLANDS.

(Source: Central Bureau of Statistics, The Hague)

| Cause of Death | 1921–1923 | | 1951–1953 | |
|---|---|---|---|---|
| | 60–79 Years of Age | 80 Years of Age and Over | 60–79 Years of Age | 80 Years of Age and Over |
| Cardiovascular diseases | 22.3 | 17.7 | 32.1 | 37.8 |
| Neoplasms | 18.2 | 7.1 | 23.9 | 11.9 |
| Diseases of the respiratory tract | 16.9 | 15.7 | 6.9 | 10.3 |
| Diseases of the nervous system and sense organs | 12.7 | 10.6 | 16.3 | 16.5 |
| Old age and ill-defined diseases | 12.3 | 41.4 | 3.7 | 10.4 |
| Diseases of the urogenital organs | 5.5 | 3.1 | 3.3 | 3.1 |
| Diseases of the gastrointestinal tract | 3.0 | 1.7 | 3.7 | 2.2 |
| Tuberculosis | 3.0 | 0.4 | 1.2 | 0.3 |
| Diabetes mellitus | 2.1 | 0.7 | 2.1 | 1.5 |
| Infectious diseases without tuberculosis | 1.1 | 0.3 | 0.6 | 0.2 |
| Other defined diseases | 0.9 | 0.4 | 2.8 | 3.1 |
| Blood diseases | 0.4 | 0.0 | 0.4 | 0.3 |
| Congenital diseases | 0.0 | — | 0.1 | 0.0 |
| Death (unknown cause) | 1.6 | 0.9 | 2.9 | 2.4 |
| Total | 100 | 100 | 100 | 100 |

the older part of the population are scarce or lacking. There are more health surveys of younger age groups (school children or industrial workers) or investigations on a nationwide scale of specific diseases or defects (epilepsy, blindness, diabetes, and so on). Data of a more or less comprehensive character on *social* conditions of the aged are available in several countries. In general, these social surveys do not enter much into assessments of health conditions, since it is rather difficult for nonmedically trained surveyors to assess health status. On the other hand, some social investigators underestimate the importance of health in the life of the elderly.

Sheldon in Great Britain was one of the first medical investigators to assess the health status of a random sample of noninstitutionalized aged persons (1945-1947). He extensively questioned 334 women of 60 years and over and 143 men of 65 years and over in Wolverhampton about their diseases, ailments, and defects. For this purpose he visited them in their homes. He found that 29 per cent were receiving medical attention at the time of the interview, and 27 per cent had had no attention in the preceding three years. Only 3 per cent of the sample were classified as undernourished (in 1945!). Twenty-five per cent of the women over 85 were too fat. Only 2.5 per cent were confined to bed, 8.5 per cent to their houses, and 22.5 per cent were limited in their movements to their immediate surroundings. Assessment of physical state showed a rating of 24.5 per cent normal-plus, 46.2 per cent normal, 29.2 per cent subnormal. Sheldon himself has put the question: "What is normal?" Thus he has highlighted the urgent need for standards of physical and mental health applicable to the aged. The lack of such standards has made it difficult to compare surveys carried out in different countries. The lack of knowledge concerning normal aging processes compounds this difficulty.

Sheldon was able to do the field work himself. The van Zonneveld study, in Groningen in The Netherlands, is an example of a survey in which many investigators were necessary. The Groningen survey aimed at gaining at a given moment an insight into the functioning and the disorders of important organs and into the adjustments which the aged persons had made to defects of these organs in relation to important daily tasks. An attempt was made to divide the subjects of the investigation into five groups according to their health status as measured by those sociomedical provisions which were considered the most suitable. With the help of 70 advanced medical students, 3,000 old people in eight random samples (one-fourth of all the aged in Groningen, a town with 140,000 inhabitants), divided according to sex and age group, were interviewed in their homes. Great pains were taken to prevent a too heterogeneous interpretation of the findings by the 70 investigators. That they were medically trained proved to be of great value. This investigation differed from Sheldon's survey in the far greater number of persons investigated, in the use of a team of investigators, and the use of certain short tests to ascertain the objectivity of the answers given by the aged. A short memory test was also included.

The data of this survey were more or less generalizable to the whole aged population in The Netherlands, as Groningen has a mixed urban-rural population. The information has since been used, sometimes in combination with results of other surveys, as a basis for discussions of plans for housing and nursing accommodations. It was interesting to note that, with increasing age, the numbers of those of both sexes feeling well remained the same and that there were significantly more women than men who complained of their health. In fact, the women had more ailments than the men. The latter situation has been found in several surveys in different countries. Sheldon, for instance, reported a curious difference between the two sexes in relation to their physical state: a distinctly larger portion of the women than of the men tended to be in a subnormal state of physical health. Hobson and Pemberton found the same: elderly women, age for age, suffered more from disabilities than elderly men. Strøm, from his survey in Norway, also reported that women (83 per cent of the sample) were more complaining of their health than men (74 per cent). All the authors cited found that, with increasing age, the number of people with disabilities also increased. Consequently we can say that, in general, though women live longer than men, women complain more and have more disabilities than men. This fact is important with respect to the provision of hospital and nursing-home care.

The Sheffield survey is an example of an investigation in which the aged were medically

examined. In 1950 a team, headed by Hobson and Pemberton, examined 192 men (of 66 and over) and 284 women (of 61 and over) in their own homes. The sample was restriced to persons who were living alone or with a spouse. Moreover, the sample was partly biased, since, of the original sample of 618, 138 did not consent to be examined by the physician, and four could not be seen through lack of cooperation of their general practitioners. However, much interesting data were collected. The investigation included an interview by a research social worker; a complete medical examination at home; radiological, dental, ophthalmic, and haematological examinations in the hospital (332 agreed to the hospital examinations); and a dietary survey (303 subjects). Since 94 per cent of the clinical examinations were carried out by Droller, this part of the study can be considered a one-man survey.

The Sheffield team found that disability was caused primarily by cardiovascular conditions (18.2 per cent of the sample was thus disabled to some extent). Extremely common were foot disorders and deformities, though these were rarely disabling. Fifty-three per cent of the men and 31 per cent of the women had varying degrees of deafness. Only 3 per cent of the men and 2 per cent of the women were considered not to need glasses. These last two findings are about the same as in the other surveys mentioned. In Sheldon's survey 38 per cent of the men and 29 per cent of the women complained of their hearing, and 6 per cent of the sample did not need glasses. In van Zonneveld: 57 per cent of the men and 45 per cent of the women of 75-79 years had impaired hearing, and 5-7 per cent of the men and 2-4 per cent of the women had no need for spectacles. The Norwegian (Strøm) and the North Irish (Adams and Cheeseman) surveys were similar. We may conclude that more men than women have impaired hearing, while the opposite (though only to a slight degree) is true for vision.

The Sheffield survey raises the question of refusals. It would not have been surprising to learn that rather a large number of the aged refused to cooperate in surveys like those mentioned above . Old people tend to be conservative, and many do not like to be interrogated about intimate matters. Moreover, people in Europe are perhaps not so well acquainted with surveys as are people in the United States. In some countries or regions or in certain religious denominations, there may be rather strong objections to this kind of research. It seems, however, that the cooperation rate is much higher than we are likely to expect. In several surveys, usually those in which questions were put, only a small percentage refused to join in the project. When a real medical examination had to be carried out, the refusal rate increased, as indicated in the survey of Hobson. In the medical survey in The Netherlands, which will be dealt with later on, this rate has been reduced considerably by arranging to have the aged examined by their own doctors. This is one important reason for engaging general practitioners when real medical examinations are needed.

In all surveys of this kind it is of the greatest value to inform the participants well in advance of the purpose of the investigation. This information should be given verbally and by letter and in the simplest words. In the author's own experience, old people often misunderstand the general meaning, or certain details, of a survey. This problem in studying old people has not been much discussed in the various surveys reviewed here.

The Norwegian survey into the health and living conditions of the aged was carried out by local district nurses in a part of Norway in the years 1952-1954. These nurses were well prepared at the Institute of Social Medicine. During the time of the survey the Institute remained in close touch with the interviewers. The random sample included all kinds of aged persons except those admitted into hospitals; the distribution was, however, not completely representative. The questionnaire consisted of about 90 questions, of which 18 pertained to health conditions. Of the 587 men and 802 women 70 years and over, 54 per cent and 38 per cent, respectively, proved to be quite fit, while 12 per cent and 23 per cent, respectively, were disabled. The great majority (84 per cent of the women and 74 per cent of the men) had one or more complaints concerning their health. The rate of unfitness and of complaining increased with age. Severe physical disability was indicated once again as a problem of the oldest age group; only 5 per cent of the group 70-79 years old and about 25 per cent of persons of 85 years and over were described as complete invalids.

### 2. *Social Surveys with Some Health Status Questions*

Other general surveys of the living conditions of the aged have been reported, but few of these were carried out by physicians or nurses. This is quite reasonable, as these surveys were not primarily intended to obtain data on the health situation. The questionnaires contained, however, a number of questions aimed at getting some information about the subjects' health.

In The Netherlands a national survey of this kind was made under Diederich in 1951-1952. In the eleven provinces, separate sample studies were made, totaling about 11,300 aged persons (65 years and over), living in 155 municipalities (15 per cent of all municipalities). About 1,000 social workers, officials of welfare departments, district nurses, members of voluntary women services, and others functioned as interviewers. They were instructed orally and by letter. Some restrictions had to be made with respect to subjects. Only old people in the smaller and middle-sized municipalities, not living in institutions, were included in the sample. For the greater part, married women were omitted, as only the male partners were interrogated. One of the interesting findings was that the number of old persons in need of aid because of their health status increased rapidly with age (65-69 years, 3 per cent; 70-74 years, 6 per cent; 75-79 years, 7 per cent; 80-84 years, 14 per cent; 85 years and over, 23 per cent). Though many persons in the higher age groups do not complain more than those in the younger groups, there is an unmistakable tendency toward growing dependence with increasing age. This phenomenon is important for public health provisions; the oldest part of the population is growing most rapidly, and it is this part that claims the greatest share of nursing and medical care. Therefore public health officers should watch especially the health trends of the oldest persons in the population, and sociomedical surveys should give more attention to this group than to the younger groups (65-70 years, for example) when morbidity rates are the chief issue. When prevention is accented, then age groups under 65 should be studied.

Most health surveys of the aged, however, make use of a random sample of the whole aged population and do not take into account the much greater incidence of disease in the oldest age group. The findings available for this group will thus be based on small numbers. In the two Dutch medical surveys the groups of 80 years and over were therefore relatively much larger than the groups of 65-70 years.

Of interest is the remark of Diederich, a sociographer himself, that most of the section on health had to be omitted, as the interviewers proved incapable of judging correctly the relative answers or situations encountered.

Sweden has also had a national survey on the living and health conditions of the aged, as had France and Finland, for instance. The number of people investigated was smaller than in Norway and much smaller than in The Netherlands. Though a careful random sample of 1,064 persons aged 67 and over was taken, it seems somewhat dubious whether such a sample in a population of 7,200,000 suffices. Of course this depends on the number of questions and on the subdivision of the material. In the part of the Swedish survey aimed at getting an idea of the proportion of the aged population in need of some kind of social or medical care, some questions regarding the health status were included. The questions especially concerned mobility, vision, and hearing. An appraisal of the health status by the interviewer was also included. Only eight persons (0.8 per cent) refused to cooperate. Considering the limited number, and the objective nature of the questions, this cooperation rate is not surprising.

In Denmark a national morbidity survey was carried out in 1951-1954. This survey did not especially cover the older age groups of the Danish population, but 22,000 of the 127,000 investigated persons of 15 years and older were over 60 years. To the original survey a special and detailed investigation concerning the older age groups has been attached (Lindthardt and Friedberg). Information was obtained by interrogation. About a fifth of all the persons surveyed have been questioned during their stay in hospitals. A very carefully composed stratified random sample has been used. The 165 interviewers were mainly housewives, but nurses, teachers, social advisers, and others were also used, as in the Diederich survey. These interviewers were instructed very thoroughly, especially with regard to the best manner of making contacts with subjects.

The questionnaire resembled the one used in the English morbidity survey. The diagnoses, as derived from the answers, were generally in agreement with the opinions of the practitioners, who were quite willing to verify the diseases stated by their patients. In the hospital survey, more than half of the questions were answered by doctors and nurses.

The final report of this survey is as yet not available, but it will undoubtedly shed more light on the health situation of the aged in Denmark. From many other findings concerning health and disease of the populations in these countries, it may be expected that this situation will not differ much from those in other West European countries. Yet one has to consider that the living and hygienic conditions in Denmark are among the best to be found in Europe.

In North Ireland a study was made of 759 persons of 60 and over (94 per cent of the original sample) to estimate the social needs of old people in their homes (refusal rate, 1.5 per cent). Three per cent were found to be bedridden, compared with 2.5 per cent reported by Sheldon. About 7 per cent were considered to be helpless, that is, dependent on others for their most elementary needs. The results gave evidence that, through supplementary care by general practitioners and more social assistance and nursing, the potential demand for admission to hospitals could be reduced. Though the situation may differ from one country to another, this conclusion may also be drawn from many other surveys.

### 3. *Regional Surveys*

A full medical examination of a sample in a localized community was made in 1952 in England by Maddison, Smith, and Olbrich. Of the original 550 persons aged 60 and over, 238 were thoroughly examined. The sample was obviously biased. When the clinical findings were subjected to factor analysis, many symptoms and signs traditionally associated with hypertension proved to be not statistically significant.

Some years later a regional inquiry into the living and health conditions of the aged was carried out in Dorset, England, by Simonds and Stewart, who interviewed 454 persons of 65 and over in their homes. The survey showed that on nearly all counts the welfare needs of women were numerically greater than those of men. The prospect of remaining healthy for some time was almost equally good for both men and women.

A remarkable survey was performed under the direction of Roberts in the city of Salford, England. Here every person in the older age group of the population within the area of the Local Authority was visited at home and interrogated on the important problems of everyday life (in the years after 1952, when a sample test of 2,000 had been made). About 17,300 older people (men 65 and over, women 60 and over) participated in the final project, and at the same time participated in numerous facilities made to help them. This seems to be a very practical kind of local survey, collecting statistical data and providing help where it is found necessary.

In Great Britain other local surveys of this kind were carried out in Liverpool (500 old persons), in rural Sunderland and urban Boldon (by Smith, who gave special attention to the food of 1,000 aged persons), in Glasgow (by Gordon) and in Leigh (especially on nutrition, 100 aged persons). Furthermore, Walker and also Gordon (Edinburgh) have made investigations of old people, the latter partly with the help of general practitioners. The surveys in Wolverhampton and Sheffield also belong in this category.

In Sweden, concurrent with the national survey already reviewed, an urban survey of 1,000 aged people took place in Stockholm and in Gothenburg.

In The Netherlands Hornstra investigated, with the help of local general practitioners, the number of old people in need of nursing home care on the island of Schouwen-Duiveland. He found 2 per cent of the persons of 65 and over were apparently in need of such care. Two other important social surveys were carried out in the two largest cities of The Netherlands. In both surveys, attention was paid to the health situation. In Rotterdam 5,800 old people were interrogated by 220 women volunteers. Nine questions concerning medical aspects of the living conditions were controlled by 162 general practitioners (nearly 90 per cent of all the doctors who were asked to do this). In 7 per cent of these questions, the doctors answered in a different way from the interviewers. In 6 per cent of the cases the interviewers had considered the health status to be good, while the general practitioners

thought it to be bad; and in 4 per cent of the cases the reverse occurred. This agreement between lay and medical people is remarkable and confirms the ideas of those who think that nonmedical interviewers can be used to assess the general health situation. Seventy-eight per cent of the aged were considered to be in good health; 99 per cent appeared to be well kept; the mental status of 97 percent was qualified as normal.

The second survey was carried out in a suburban part of Amsterdam. Of the original sample, 7 per cent refused to cooperate. In all, 312 couples, 36 single men, and 144 single women of 56 and over were visited. Thus, people in their later fifties and early sixties were included. This method offers an advantage in that these people in the next ten years will belong to the "aged" group. Thus prediction of their problems can be made more easily. Of the surveyed, 2 per cent were bedridden and 3 per cent in need of nursing care. About two-fifths of the women and one-fifth of the men complained of sleeplessness.

Various other local surveys have taken place on a smaller scale or with less extensive questionnaires, as in Utrecht and Zaandam. In the latter, about 20 per cent of the aged (800 persons) were investigated, partly in the same way as in the sociomedical survey of Groningen.

In Basel, Switzerland, Vischer conducted a survey on lines similar to those used by Sheldon in Wolverhampton. The final data are not yet available. It is a propos to recall Vischer's remarks at the Third International Congress: "Such surveys [as those of Sheldon and others] are valuable, not only for obtaining information about old age, but also for giving a picture of the conditions of old people in different countries."

Another local Swiss survey of the aged, in which some attention was given to the health status, may be mentioned. In two villages of the Valais Canton, Rossetti visited about half of the indigent old people (100 persons). Though her factual results are too limited to supply much information, one point makes her little survey of special interest. She also gave attention to the psychic components of the health condition (the influence of disease on the behavior, the importance of health in the whole situation, and so on). Rossetti, a social worker, also observed, as have many others, how easy it often is to dig deeper through starting the interview with questions on the health conditions.

### 4. *A Comprehensive Medical Examination in The Netherlands*

The National Health Research Council T.N.O., which subsidizes or carries out scientific researches to promote public health, has for about five years focused its attention on gerontology. In 1954 its advisory committee on gerontological research decided to start, with the help of general practitioners, a pilot survey of the health conditions of the aged to get an insight into the possibilities for organizing such a survey on a national scale. The purpose would be to assess the real health status of a rather large number of old persons, to find out which medical problem of this group ought to be tackled first, and to interest general practitioners in scientific work and geriatrics. The choice of the family doctor as an investigator was based not only on this last consideration but also on the assumption that the investigator should be medically trained and that the family doctor of the aged man or woman was the most suitable person to make the medical examination.

After the pilot survey, with the help of twenty general practitioners, had proved that both the examination along the lines drawn up by the group and a reliable random sample were possible, the cooperation of a large number of general practitioners was obtained. The survey started in the summer of 1955. Every general practitioner joining in the project agreed to examine ten out of the people of 65 and over who had chosen him as their doctor (in The Netherlands more than 80 per cent of the population is insured against medical costs.) The general practitioners made this research voluntarily and without fee. Nearly all sick funds and many municipalities assisted. Eight random samples were made for every participating doctor in order to get eight equal age and sex groups. It was considered of value that the older age groups were represented more heavily than the younger age groups in the sample. The questionnaire consisted of three parts: an extensive anamnesis, a thorough medical examination supplemented with some laboratory tests, and a socio-psychological part dealing with activities, adjustment to old age, feelings about old age, etc. Included was a memory-test, as in the Groningen survey. The

whole examination took about three hours per person. To obtain as objective data as possible, about twenty teams of investigators were formed to discuss methods and early results.

Though some preliminary results have already been drawn from the first 1,000 questionnaires, the final results cannot be expected for at least a year. An important result was the real interest in geriatrics and gerontology that was aroused in many of the cooperating physicians. Even so, this last survey will give, in spite of all advantages, only the situation at the moment. Longitudinal sociomedical studies of aging people have not been made in Europe, and none, as far as is known, is now in progress. Such studies are quite necessary.

### 5. *Specific Investigations*

Besides the general health surveys or social surveys including questions on health of the aged, a number of specific investigations have been made in several countries of Europe. While the latter were restricted to special aspects of gerontology, they yielded important data, supplementing the knowledge gained from the former. These surveys can be divided into two parts: investigations into special groups of the elderly (such as institutionalized aged and chronically sick old persons) and surveys on public health aspects of certain diseases or defects (mental illness, suicide, accidents, tuberculosis in the aging and aged, etc.).

#### *a.) Surveys of Special Groups of Aged Persons*

One of the first was the hospital survey in Northern Ireland (Adams and Cheeseman). In 33 hospitals, 1,625 patients aged 60 and over were interviewed, and visits were made to the homes of 280 of them. The aim of the survey was to estimate the accommodations available for elderly people, to assess the demand, to ascertain the medical and social conditions of the old people admitted to the hospital at the time of the survey, and to assess the future needs for hospital beds in relation to the home circumstances.

Thirty-seven per cent of the adult patients in general hospitals, and 32 per cent of those in mental hospitals were 60 years and over. With advancing age the proportion of old people in general hospitals increased considerably (60-64 years, 5 per 1,000 people; 80 years and over, 19 per 1,000). In total, 9.2 per 1,000 persons aged 60 and over were patients in general hospitals and 9.6 per 1,000 in mental hospitals. Of the 1,625 aged patients in general hospitals, 163 were considered to be fit for care in residential homes, and 831 for care in long-stay institutions other than hospitals. The Northern Ireland survey was one of the first to focus attention on the urgent need for nursing homes.

More or less similar hospital surveys were made in the English cities of Leeds (Affleck, 1947), Birmingham (Thompson, 1949), Birmingham and Stoke-on-Trent (McKeown and Lowe, 1950). (The first Birmingham survey of 714 aged hospital patients formed the first part of the larger survey, described by McKeown and Lowe.) The aim of the Birmingham survey was to examine the medical, nursing, and social needs of the 1,005 patients in an institution for the chronically ill, who had been transferred to the Birmingham Regional Hospital Board in July, 1948. One of the principal conclusions was that three-fifths of these patients did not require hospital treatment at all, while only one-fifth required frequent medical attention or skilled nursing. These results clearly pointed to the need for adequate provision for home services in addition to nursing homes. As a sequel to this survey, the investigation of 393 patients seeking admission to a hospital for the chronically ill can be considered. It was found that 40 per cent of these needed skilled nursing and/or medical attention at least once a week, 24 per cent ought to be admitted to a long-stay annex, and 10 per cent to a mental institution, while 26 per cent could be looked after at home.

The Stoke-on-Trent investigation of the chronic sick in four hospitals gave about the same results. From these figures we can learn how great the impact of aged persons is on hospitals. The more old people there are in a population, the greater the need for hospital beds. Aged persons need relatively more beds than younger people.

In 1955 a survey under the National Health Research Council T.N.O. was undertaken by Bronts and van Zonneveld on the number, diagnoses, and length of stay of patients 65 years and over admitted to a number of general hospitals of various kinds in The Netherlands on a number of days in 1924, 1939, and 1954 (21 hospitals). The percentage of old patients increased from 6.9 in 1924 to 9.6 in 1939 and 16.3 in 1954, while the percentage of old people in the total population of the towns

which the hospitals served increased only from 5.9 in 1924 to 9.0 in 1954. The distribution over five-year groups followed the same pattern as in the total aged population. The aged formed nearly a quarter of all admissions to the medical and surgical departments in 1954. Their length of stay was two to three times that of all patients. However, while the length of stay was 99 days in 1924, it decreased to 54 days in 1954, while the decrease for patients of all ages was from 32 to 22 days.

In France, notably in Paris, Estève, Vannier, and Chiquet, as well as Magdelaine and Pequignot also studied the incidence of old-age illnesses, hospitalization, and the needs of hospital beds for older people in the years 1953-1954. In some of these inquiries, 18 hospitals were involved, but no comparison was made with other periods, as in the Dutch investigation. The results and conclusions, however, are similar. Nearly 30 per cent of all hospitalized patients were 60 years and over. In the departments of general medicine for adults, this percentage was 40. The ratio between hospitalized men and women of over 60 appeared to be nearly corresponding to the national French statistics (39 per cent men, 61 per cent women). The numbers of patients suffering from one or more specific diseases and their duration of stay were calculated separately for four age groups. Such figures as the Dutch and the Parisian inquiries have yielded are still lacking in most countries. They are useful for hospital management and policy. A less extensive inquiry was made by Delore elsewhere in France from 1952 to 1956. The proportion of patients aged more than 65 who were admitted into a general medical service was 28 per cent (men, 18 per cent; women, 44 per cent). The principal reason for hospitalization was cardiovascular disease, which was found in 22 per cent of the cases).

An Italian survey by Ingegnieros and Nava studied the cases of 2,003 men of 60 and over and 2,572 women of 55 and over who were admitted to university clinics in Milan in 1955. The elderly formed about one-fifth of all admissions, their period of hospitalization varied from about 31 days for men and 37 days for women in the medical wards to about 17 days for men and 13 days for women in the surgical wards.

Somewhat similar studies have been undertaken in nursing homes or in wards for the chronic sick. A limited survey both in hospitals and in homes for the aged was carried out by de Wolff, a social worker in the Canton of Neuchâtel, Switzerland. She found that the general hospitals had great difficulty in keeping so many long-term patients, and she noticed also that in the residential homes about one-sixth of the aged were chronically ill and needed more nursing and care. A similar study with a greater number of patients, though also restricted to a few hospitals and nursing homes in Basel and Zurich, was made by Zimmerman, a physician. He compiled data chiefly from the old-age home attached to the general hospital in Basel. He concluded that the need for hospital beds for the chronically ill and for the aged is steadily increasing. Especially the age group 75-84 produces many nursing cases. About 25-28 beds per 10,000 inhabitants in Basel and Zurich are needed (nine beds for mentally ill old people).

Zimmerman's investigation can be considered a supplement to a survey of the situation of 304 chronically ill and old people who asked for nursing care at the Municipal Health Service in Zurich. Three social workers, Kocherhans, Reich, and Sigg studied the reasons, diagnoses, and clinical pictures of these patients and also their social, financial, and occupational situation. Their conclusions were similar to those investigators cited earlier: there ought to be more nursing homes for the aged, more home care, and more attention to the psychological problems related to age and disease. Marthinsen found in a Norwegian survey of 547 residential and nursing homes (not including specialized nursing homes) that only 10 per cent of the inmates were not in need of any nursing care.

It may be concluded from all these studies that the aged occupy a proportionately larger share of the hospital beds than do the younger age groups and that the former stay longer in hospitals than the latter. This finding of course is not surprising, but it accentuates the fact that the hospitals will be serving more and more the older age groups. In general, the accent should be on the needs of the invalid aged.

At this point a few investigations may be mentioned in which more penetrating examinations of the inmates of institutions for the aged are made. Two studies are in progress in the large municipal homes for the aged at Rotterdam and Amsterdam in The Netherlands,

partly under the auspices of the National Health Research Council T.N.O. In both investigations, use is made of the same form as that used by the general practitioners in the medical survey of the aged already described. At the Rotterdam home, in addition to these medical and social investigations, several more examinations (E.C.G., a variety of laboratory tests, vaginal smears, portrait studies, eye and ear examinations, autopsies, etc.) are carried out by a team of specialists. In Amsterdam also some additional examinations take place. Since both healthy and ill old people are cared for in these homes (the latter in nursing departments), the results of these surveys will supplement those of the general medical survey of the aged reported on earlier. The Amsterdam study is to be repeated within two years.

In the old age home in Basel, Switzerland, the inmates were investigated sociologically and psychologically, while also a study was made of the autopsies of 1,836 old people who died in the years between 1924 and 1948 at that home. Medical examinations, however, have not been carried out. Another Swiss investigation by Mersing tried to find out the meaning of illness to the inmates of an old-age home and to discover how old people were cared for at six residential homes. Though these studies in themselves do not give much information, they draw attention to more or less neglected aspects of gerontological research in institutions.

Though a few similar investigations have been mentioned, there is a difference between those and the following. In these the aged did not come intending to be admitted to a hospital or other institution.

An interesting report comes from Rutherglen, Scotland (Anderson). Here a Consultative Health Center for older people, which will be discussed later, is operating. Since the center is open to healthy and to ill persons over 54 years of age, a considerable number of aged people can visit the center without having complaints. Anderson reported in 1954 that about one-fourth of 400 cases seen from 1952 to 1954 did not complain of their health. Men were in the majority, though men and women attended the center in equal numbers. The commonest complaints were pain in various parts of the body (joints and limbs especially), breathlessness on exertion, weakness, and giddiness. The most frequent clinical diagnoses were hypertension, microcytic hypochromic anemia, and osteoarthritis. In another review of 323 men aged 65 and over, Anderson and Cowan found that most of the retired men were compelled to cease work. The common causes were "heaviness" or "strain" of work, ill health, and compulsory retirement. Seventy-one of the 323 men retired because of ill health, caused especially by degenerative diseases of the arteries (20), diseases of the lungs (14), and accidents (10). Of the 80 men still working, 41 were not in good physical condition. Such a consultative center offers great opportunities for sociomedical research.

An inquiry into the economic situation and the physical and psychological state of 100 persons 60 and over visiting the medical outpatient clinic of the University Hospital at Geneva was made by Barth, a social worker. The survey itself is of minor importance, but it is valuable as an example of a simple investigation which gives considerable information on the social and medical situation of the aged suffering from disease. Such inquiries are still too few. They will be especially helpful in assessing the local health needs of an aging population. Of the 100 persons investigated, 38 had cardiovascular diseases; 21, diseases of the respiratory tract; 29, gastrointestinal and nutritional defects; 32, diseases of bones and joints; 16, nervous diseases; and 7, other diseases. The presence of more than one disease at a time, a well-known phenomenon of old age, is again demonstrated. A great number of the 100 persons also had signs of depression.

The survey of Schreuder in South West Frisia, The Netherlands, can be compared with Sheldon's. In both cases a senior hospital physician visited the elderly in their homes (Schreuder also visited the homes for the aged and so-called nursing homes), and in addition information was obtained from the general practitioners. Schreuder, however, visited, not a random sample of old people, but only those who were considered chronically ill by their family doctors, and he examined all the elderly patients himself. His aim was to get an insight into the medical and social conditions of all the chronically ill aged persons in the area and to derive from his results soundly based suggestions for improving their condition.

Of a population of 87,695, including 9,038 people of 65 and over, he saw 512 persons who were considered chronically ill or disabled.

These 151 men and 361 women were medically examined by Schreuder, with the help of their general practitioners and district nurses. Of these, 133 were living in old-age institutions. A total of 475 were found by Schreuder to be more or less disabled; 139 (27 per cent) were considered disabled and incapable of rehabilitation; 94 (18 per cent) could be totally rehabilitated; the remainder (242 persons) were disabled and capable of partial rehabilitation. One hundred eighteen persons were bedridden; 317, partly ambulant. Schreuder also found that 55 per cent of the patients living with their relatives had an unfavorable influence on their environment, while in 30 per cent the environment had an unfavorable influence on the patient. The principal reasons for disability were arthrosis deformans (35 per cent), hemiplegia (12 per cent), cardiovascular diseases (11 per cent). Twice as many women as men were disabled.

*b) Surveys on Public Health Aspects of Certain Diseases or Syndromes in the Elderly*

Accidents tend to take more and more victims in all age groups, but the aged account for more than their proportionate share.

Fleetwood (Eire) surveyed 304 accidents in men and women of 65 and over. Of these, 97 (almost equally distributed among men and women) were due to falls, 70 to road accidents, 50 to fire, 11 to drowning. Men had twice as many outdoor accidents as women, while the reverse was true for indoor accidents. The financial or social status of the victims did not appear to be of importance. Thirty per cent of the accidents had a direct or indirect relation to the individual's medical condition.

Droller worked out the data on falls and accidents obtained in the Sheffield medical survey. Thirty-five per cent of a random sample of elderly people (476 persons) living at home were subject to falls, mainly because of vertigo, arthritis, and weakness. Women fell more than men. More than 10 per cent of the sample, or 28 per cent of those liable to falls, had sustained fractures after the age of 60. A greater number of persons, considered medically unfit after an examination, were liable to falls. The importance of a real medical examination for a better evaluation of the data is exhibited once again. Thus it was also found that those who were more subject to falling showed greater evidence of pyramidal tract damage. Howell (England) analyzed, in a hospital for the chronically sick, the aged (4.5 per cent of all those needing admission in 1952) who were referred solely because of the likelihood of their falling; he found seven major varieties of fall according to etiology and mechanism. Information about road accidents was offered at a conference devoted exclusively to the safety of the aged on the roads, which was held in London in 1953.

Friedhoff (West Germany) analyzed 511 severely wounded persons of 60 years and over who were admitted to a hospital at Cologne. Traffic acidents were the most frequent cause, followed by accidents suffered in the home. Nearly 14 per cent died as a result of the injuries. Head injuries stood in first place, comprising 27 per cent of all injuries. Several other studies have been made on the relation between age and accidents. Häkkinen (Finland) investigated all the road accidents over a period of six years. A total of 500 drivers were involved. He found that the older drivers were, on the whole, more careful and cautious. As a result the total number of accidents, the amount of damage, and the percentage of responsibility in accidents were, on the average, smaller for these older drivers.

Alcoholism in old age has been little studied in Europe. Cavalieri drew attention to this fact while describing a study of the aged in a large institution in North Italy. All these persons were from low cultural and economic conditions. Cavalieri pointed out that the large consumption of alcoholic beverages by the greater part of the inmates of the institution was not so unfavorable as would be expected. They did not suffer from nutritional deficiency, and those who drank great quantities of wine appeared to have made better adjustments to old age than had the aged persons who did not drink. They worked more (to earn money to buy the wine!), and they complained less of minor ailments than did a control group. Was their habit of drinking perhaps preventing a neurosis? As a result of these findings, Cavalieri warned against repressing the drinking habit too quickly in old people, especially in those countries where numerous groups of the aged drink, as in Italy, before all the factors that determine adjustment in old age in a particular culture have been studied.

It is a well-known fact that more persons in the older than in the younger age brackets

commit suicide. Since suicide presents a definite mental-health problem, it is somewhat surprising to find almost nothing in the literature concerning research or prevention. The Netherlands investigator, Kruyt, is giving attention to the old-age factor in his socio-psychological study of suicide, but the work is still in progress.

In many countries, population surveys have been carried out, in which one specific disease or syndrome was investigated, as tuberculosis, goiter, rheumatic diseases, etc. When the results are evaluated statistically for the separate age groups, surprising data have sometimes been found. It is beyond the scope of this review to go into details, but one fact which is already well known may be mentioned: in many West European countries tuberculosis is more and more manifesting itself in the older age groups.

### 6. *Other Investigations of Well-being of the Aged*

Various types of surveys have been carried out on the social conditions of the aged in many countries. Several of the most important inquiries have been cited in the previous pages, and it is beyond the scope of this review to enter into details. It will be clear, however, that the results of many of these surveys can also be of importance for the health of the aged.

Generally, social surveys focus on one or more of the most pressing problems of the aged, such as employment, retirement, income and budget, housing, leisure activities, adjustment, and social roles. Some may be mentioned briefly because of their concern with health.

#### *a) Surveys of Health, Employment, and Retirement*

There is much discussion about prolonging the human working span. In some countries this has been achieved, as in Norway, Sweden, and, to some extent, in Great Britain. An example of research was the work of Brown, McKeown, and Whitfield in Great Britain, assessing the physical fitness for employment of approximately 100 representative men in each year of age in their seventh decade. In all, about 85 per cent (1,062 persons) of the 1,234 men aged 60-69 on the panels of 11 doctors in Birmingham were examined. The investigators found that there was actually only a small reserve of labor beyond the retirement age (65), that at least three out of every four men were willing to work beyond that age if given the opportunity and financial incentive, and that nine out of ten were physically able to work. What was most interesting was that, on medical grounds, no reason for retirement at 65 apparently existed in this group.

A somewhat similar survey was carried out in Norway in 1951. Information was collected from 4,980 men over 60 years of age and 1,307 women over 55, as well as from employers and industrial physicians. The latter thought that 84 per cent of the subjects would be able to work full time, 3 per cent part time, and 13 per cent should retire. Only 25 per cent of the employees wanted to retire. These figures do not differ much from the British findings.

In Sweden an investigation has been in progress since the end of 1956. The Swedish Institute of Public Opinion Research is collecting material on how older people react when they reach the pension age and how they get along as pensioners. Among the aspects to be investigated are the state of health and "vitality." The survey will probably be completed by a second interview after two years and a special medical survey, consisting of a follow-up interview by physicians to compare the older people's judgment about their ability to work with the reality.

In Scotland a similar survey (Emerson) had been started earlier. People were interviewed shortly before, just after, and some time after their retirement. No reports are as yet available. Fiandaca and Trompeo (Italy) reported some time ago on a method of statistical research to find out the further working possibilities of old people. They seem to have obtained results.

In summarizing, it appears that only a few non-comprehensive surveys on the very important relation between retirement and state of health have been carried out in Europe. The results do not yet suggest special trends.

### 7. *Surveys of Relationship of Migration and Health*

As far as can be concluded from the reports, almost nothing has been done to discover the relation of migration and the health of older persons. In 1955-1956 Treanton (France) interviewed 259 elderly Parisians on their adjustment to urban life. Only 1.7 per cent of these mentioned their state of health as an unfavor-

able factor for moving out of Paris. Some old people were afraid of not getting proper medical treatment in the provinces. This finding is important. If it should be considered desirable to move old people out of the large cities, it would be necessary to offer them favorable conditions in their new surroundings, and one of these conditions would be adequate medical provisions. In this respect a British study by Townsend may be cited. A random sample of about 200 people of pensionable age in an East London district were interviewed in 1954-1956 to find out to what extent they were isolated from their families. One of the interesting results was the finding that between 5 and 10 per cent of these people might have required hospital care but for the help of families and friends, and another 5 to 10 per cent might have required admission to a residential home. Such data show again the importance of relatives and friends in caring for the health needs of the aged. They also indicate that migration from the place where the elderly have lived for a long time can have many disadvantages by disrupting the "extended-family" ties. It would be interesting to investigate possible differences in various countries of Europe and differences between the Old and the New World.

### 8. *Surveys of Use of Medical Services*

Under the auspices of the World Health Organization a survey has been started in several countries to ascertain to what extent, in what way, and under what circumstances people use the available medical services and provisions. These studies will probably also reveal figures regarding the older part of the population. A survey is also to be started to assess the merits of existing meal services for the aged in Great Britain. We need more such surveys with respect to many more of the various social and medical services that are being offered to old people.

The National Corporation for the Care of Old People in Great Britain decided some years ago to compare the cost of maintaining ailing old people in their own homes with the cost of keeping them in welfare or nursing homes. It appeared that often the costs were the same.

### 9. *Conferences and Seminars*

The public health aspects of aging populations have occupied, and continue to occupy, the attention of various regional, national, and international conferences. The Regional Office for Europe of the World Health Organization took up the topic for the first time at its annual meeting in Vienna in 1955. Indeed, the epidemiology of old-age diseases may become one of the major issues in the field of the activities of the W.H.O. in this part of the world. A special study group will start its work in 1958.

At some international conferences the sociomedical implications of aging populations were also discussed to some extent. The first of these was perhaps the conference in Sheffield preceding the Third International Gerontological Congress in 1954. European and American investigators coming from various disciplines discussed, among other problems, the sociomedical problems of old age. As a result, the Social Research Committee of the International Association of Gerontology, with its European and American sections, was formed.

The European section held a meeting at Copenhagen in 1956 on the theme "The Need for Cross-national Surveys of Old Age." In one of the working groups at this conference, concerned with family and institutional care, many proposals were made for research of special interest to public health workers. One of the major conclusions was that there is great need for agreement on the definitions of the various terms used. A third conference of the committee took place in Merano (Italy) the week before the Fourth International Congress in July, 1957. The theme was "Aging and Social Health."

Other conferences have also focused attention on the public health aspect of old age. In 1955 in Helsinki, Finland, the Conference of the Scandinavian Medical Officers of Health was devoted to this subject. In 1956 in Brussels, International Study Days were held on old-age problems.

In many national conferences or congresses, attention was drawn to the consequences that an aging population has for medical services. In 1956 in The Netherlands a national health congress was entirely devoted to the problem of the aged. Reports were read on the social and medical basis of the care of the aged, the social and medical aspects of housing for the aged, and similar topics. Conferences have been held also in France, Italy, Switzerland, Great Britain, and Belgium. Often one or more

foreign speakers were invited to high-light the problems and, if possible, the solutions in their own countries. There is in all these meetings a growing tendency to devote more attention to the public health aspects of aging in the population.

## PART II. PRACTICES AND PROGRAMS

### 10. *Public Health and Welfare Programs for the Aged*

It is extremely difficult to give an overall picture of public health and welfare programs. Each country has its own development and its own ways of tackling the problem. However, there are some principles that are generally accepted. Caring for the aged is no longer looked upon as a matter of charity but as a requirement of social justice. The aged are considered to be full and active members of society. They must be free to choose how they want to live. The aged should be enabled to live independently and to take care of themselves as long as possible. In addition to sufficient financial resources, it is necessary to provide various kinds of services, including home medical care. Only when home care becomes too risky, too difficult, or too expensive, should transfer to an institution take place.

This is the ideal concept toward which the West European countries are striving. However, many persons still believe that admission to some kind of institution offers the greatest benefit to the aged individual and will be the final solution to the "problem of the aged." As far as is known, no real attempt has been made to demonstrate the superiority of either course. Everyday experience, however, leaves little doubt that a feeling of independence is a favorable influence on the well-being of the aged. Thus efforts are made to provide the aged with the facilities to maintain their independence. Financially, this means a system of pensions enabling them to meet the daily costs of living or a rise in the pensionable age. Many countries have state pensions which benefit many of the aged. Some countries have raised the age of retirement, for example Norway, to 70 years; Sweden, to 67 years; Great Britain, flexible until 70 years. Medically, maintaining their independence means prevention and treatment of disabling diseases and defects among the aged, especially physical and mental rehabilitation.

*a) Housing*

Housing is one of the major problems in the care of the aged in many countries of Europe, now that the greatest financial worries have been cared for. Sometimes surprisingly great activity is developed to provide the aged with adequate housing. Until recently this activity consisted mostly in building old-age homes which could house large numbers of old people.

This trend seems to have been more or less abandoned for two newer concepts: (1) the building of small units, preferably small houses, without concentrating too many of these in one place; and (2) construction of smaller residential homes by limiting the number of inmates to a maximum of 100. Individuality and personality can be given more scope in small homes than in large homes. It is sometimes possible, however, to obtain similar results in larger homes with a system of wing or floor units. The solution that seems most promising is to group a number of small houses around a central building. Various kinds of help can be offered to the inhabitants, such as hot meals, laundry service, domestic help, health visiting, etc. Such a "mother-home" can also include facilities that will allow them to admit frail ambulant aged persons who are temporarily or permanently unable to look after themselves. Several of these "centers for the aged" can be found in The Netherlands, Great Britain, Sweden, and Denmark.

It is especially interesting to follow this development in Denmark. Until the present, one of the best ways of caring for the aged was considered to be the construction of large residential homes or enormous apartment buildings. Now the types of housing mentioned above are accepted in many parts of the country. However, in countries where many people, and especially the aged, live under miserable social conditions, institutional housing offers a more realistic solution.

In many countries the principle of differentiation between more or less healthy old people and the ill or disabled aged persons has been accepted. The healthy and the sick should not mingle too much, as this will often have an unfavorable influence on both groups. It will also inconvenience personnel. In general, the two groups should not be housed together unless there are two well-separated and functionally independent departments. From the point of view of modern nursing, separate care

can be provided only in well-equipped and well-staffed nursing departments provided with facilities for rehabilitation. A minimum capacity of 75-100 beds appears to be desirable to permit financially sound operation, according to special studies by the International Study Center for Building at Rotterdam. Such departments would necessarily mean large homes, if both categories of aged are to be admitted. At present a great many homes of the old-fashioned, mixed type still exist. A report from Hungary relates that about 24 per cent of the inmates of old-age homes are bedridden and that nearly a third of all beds in these homes serve the nursing of really ill old people.

*b) Domiciliary Services*

The modern concept of the accommodation of the aged is that many old people should be helped in their own surroundings. This refers not only to those living in new types of housing but also to those still living in their own houses.

One of the crucial points in the modern care of the aged is the lack of women workers for helping in the home and for other social community work. As long as salaries are low compared with earnings in industry, most young women will not enter the social occupations. Also the demand for women in these professions is much greater than it has ever been. There is, however, a reserve in the middle-aged women. In several countries these women have begun to be attracted to social work with the aged. In the larger cities of Sweden, Switzerland, and Great Britain, help in caring for their homes is provided for old people. Middle-aged women, whose households do not need all day care, aid the elderly, with or without fee.

Old persons can often be nursed at home or at the homes of relatives. Many aged patients are nursed at home in every country. The district nurse is generally considered the most capable person to look after them. To relieve her of a number of simple but time-consuming nursing operations (bathing, dressing, etc.), she can be assisted by nursing aides. Besides the care by persons in the home and by district nurses, there are many other possibilities of helping the aged. These facilities are "meals on wheels," laundry service, chiropody, health visitors, night attendance, friendly visiting, etc. In almost every country there are numerous domiciliary services. The number of new services is still growing rapidly. Great Britain undoubtedly leads the way in this respect. A well-organized network of more than five thousand local committees has existed there for some years. In these committees, local authorities and private organizations co-operate. In several other countries a somewhat similar movement can be observed. The co-operation of governmental and voluntary organizations is most important in such welfare work. In countries where there are no private organizations, the whole load of care falls upon the local government.

*c) Occupational and Recreational Activities*

It has not yet been proved that physical and/or mental activities lead to greater well-being in the aged. Common sense and everyday experience indicate that some activity is wholesome, although rest is very important for old people. The aged themselves should judge how to organize their time.

The need to provide well-organized programs of leisure-time activities does not seem so great in Europe as in the United States. Only in Great Britain are there similar activities. Clubs for the aged play an important role in that country. Although several clubs or societies for the aged are found on the continent, this kind of social occupation is more common with the British. "Club-mindedness" is apparently not so highly developed in the other European countries. In certain regions the aged even dislike gathering in clubs or societies made up exclusively of old people. This does not mean that the majority of the aged do nothing; they find other outlets for their occupational and recreational needs.

Nevertheless there is a growing tendency in many European countries to pay more attention to this important aspect of aging. Voluntary organizations are occupying themselves more and more with the provisions of opportunities for recreation. Local authorities often show their interest by subsidizing such work. The aged themselves also seem to be in greater need of this service than they formerly were. Industrialization and urbanization has undoubtedly increased this need. Gainful part-time employment is offered here and there, but, in general, extensive programs for this kind of occupational activity do not exist.

*d) Medical and Public Health Care*

Here again a diversity of methods and programs can be observed, but there are some general principles. It is agreed that old people should receive all the medical care they need at a price they can afford. In Scandinavia and Great Britain nearly all old people are covered, as are younger persons, by the National Health Services. Other countries have somewhat different systems, which enable the aged to be insured against diseases on very moderate terms. In The Netherlands, for instance, about two-thirds of all the aged have voluntary health insurance, for which they pay very low weekly premiums (according to their income, the family premium per week is the equivalent of $0.25 or $0.50).

Generally speaking, the indigent who are not covered by any insurance system get free medical care from the local welfare authorities. Usually ill health does not mean a financial catastrophe for the aged, and financial straits form no obstacles to treatment. In practice, however, supplying the same medical provisions to the aged as to younger people still meets many difficulties, especially with regard to hospital care. With the shortage of general and mental hospitals existing in all European countries, the aged sick often are not admitted or are admitted too late. Almost everywhere the facilities for treating the aged sick are insufficient. Only Great Britain and some other regions or cities (such as Oslo) have well-equipped and well-staffed geriatric services. Such services consist of geriatric hospitals (or geriatric departments in general hospitals), geriatric outpatient clinics, nursing homes, half-way homes (convalescent and observation homes), long-stay annexes, visiting and after-care services.

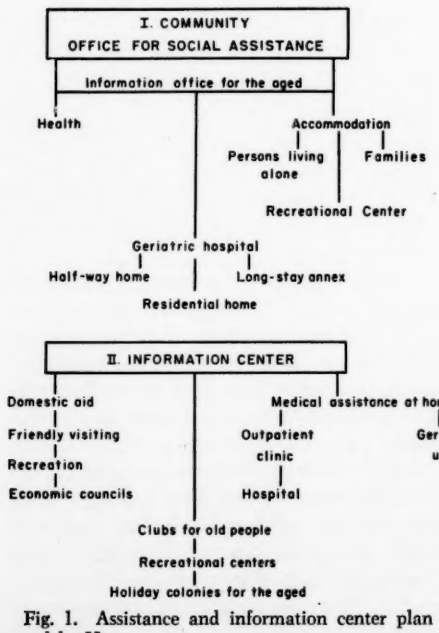


Fig. 1. Assistance and information center plan proposed by Huet.

The gerontological experts in Europe exhibit little difference of opinion on the general scheme of such services. Many subscribe to Huet's plans, which have already been partly realized in France. Huet considers the information center a fundamental necessity for the geriatric services. The director of these services is usually a general practitioner or a general physician, who is called a geriatrician.

According to Gaustad, chief of the Geriatric Department in Oslo's Ulleval Hospital, which is a well-run entity, a geriatric department of a general hospital should provide a general medical examination, treatment and nursing care, rehabilitation to achieve as much self-dependency as possible, and classification based on medical and social information to assess the future accommodation of the aged sick. Close cooperation between hospital and other socio-medical services is important. Comprehensive organizations are a necessity in health and welfare centers for the aged. Among the best-known health and welfare centers for the aged are those in Oslo. They attempt to consider the totality of problems facing the aged. Accordingly they have extensive programs of activities to insure proper living and health conditions for the aged who live at home. Among the services offered are domestic-help, volunteer home visits, hot-meal service, health control, chiropody, recreational activities, advice and guidance. Volunteer organizations play an important role. A joint registration center is a necessity, as decentralization is encouraged. Clearly the Norwegian, French, and British schemes are much alike. According to the opinion of some physicians (Bonazzi, Ercoli, Huet), temporary colonies for old people in spas, etc., should also form a useful part of the services.

The approximately 70 geriatric services in Great Britain have been in operation longer

than most services on the continent. In cities and in rural areas they fulfill an apparent need. Warren, Agathe, Wilson, Cosin, Amulree, Howell, Exton-Smith, Nagley, De Largey, to mention some well-known British geriatricians, have described their experiences with their services and with certain modifications which they introduced in the general scheme. Marjory Warren was the first to operate a geriatric unit and to introduce the idea of the so-called half-way homes. These are convalescent and observation homes, standing between the hospital and the normal living place. Cosin is well-known for his day-hospital project. The aged sick spend only the night at home; during the day they are treated and cared for at the hospital. In other programs admission is offered only for the night. De Largey recently reported on his plan to admit ill old people for six weeks, at more or less regular intervals, to relieve the family of the heavy burden of nursing an old father or mother. Many geriatric hospitals offer occasional help, as in summer time. Social situations lead again and again to hospitalization, as Howell found in his Croydon survey. As the tendency is to admit to hospitals primarily medical cases, many geriatricians or members of their staffs make home visits to persons who ask for admission in order to assess their real needs.

The geriatric departments in Oslo and Stockholm have recently constructed special buildings or are situated in new buildings. In Great Britain, France, and other countries they are located for the greater part in converted almshouses or workhouses. What matters is not so much the equipment as the atmosphere. Availability of a rehabilitation department with facilities for physical and occupational therapy is always considered a necessity.

A *sine qua non* is the coordination and cooperation of health and welfare services. Separation of the healthy and the ill old people seems to facilitate their proper handling. This plan is followed in some countries, as in Great Britain, Norway, and Sweden. In Great Britain the more or less able people are looked after by the local authorities (social welfare departments), and the disabled and sick fall under the National Health Service. In Norway and Sweden the same division of the responsibility between the social welfare and the hospital administrations can be observed. Cooperation on the local level prevents neglect of the intermediate cases. In many countries some confusion often exists concerning the authority to which certain cases belong.

Residential homes, and especially the nursing homes, are a matter of great concern for both public health and welfare services in many countries. Often these homes are run on a profit basis—a situation which, in general, is considered improper. Moreover, they do not always provide adequate care and nursing. The tendency is to have all these homes operate on a non-profit basis and to insure statutory control of the financial, housing, and medical conditions. The present situation differs from one country to another.

Another point of controversy is the exact purpose of residential homes. The tendency is more and more to reserve these homes for the non-sick and the non-disabled. The ill should stay in modern nursing homes after examination and treatment in a hospital. The need for such nursing homes is almost universal in Europe. Geriatric hospitals as well as home services cannot work properly when nursing homes are lacking. They form an essential part of the integrated geriatric services.

### 11. *Programs for Prevention of Ill Health*

It is naturally most important to prevent the aged from becoming disabled by diseases or defects. The outpatient clinics attached to the geriatric hospitals do something in this respect, though they are usually meant for those who are already in need of medical advice. There are also a few health centers where healthy old people are examined thoroughly. The results of one of these, at Rutherglen in Scotland, are quite promising, according to Anderson and Cowan.

Early reporting of declining health conditions in the aged can considerably prevent further deterioration and promote recovery. It appears that relatively little assistance at home can often eliminate need for admission to a hospital. No country in Europe, as far as is known, provides general medical examinations at regular intervals for great numbers of elderly people who are apparently still in good health. People in many countries, and especially the aged, do not like to visit their doctors when they do not have complaints. Sometimes there are religious objections; there are financial difficulties; and, finally, there are doubts on the

part of the medical profession as to the ultimate values of such multiple screenings.

The ever growing number of demented old people occupy a disproportionate number of the available beds in the mental hospitals. Consequently, hospitals often admit only seriously disturbed aged persons. The solution lies in the establishment of special nursing homes for the aged with mild mental diseases. This will relieve the mental institutions. In Denmark, Sweden, The Netherlands, and Great Britain, a number of such special nursing homes already exist. An interesting experiment was undertaken by Cosin (Great Britain) who in his geriatric unit formed groups of six frail, ambulant, but mentally healthy old persons with two mentally confused aged persons. According to his experience, this method often results in the amelioration of the mental state of health of the latter. A somewhat similar effort is the boarding-out of a confused elderly person in a foster family. Prevention through improvement of social conditions is of the greatest importance. Health visitors, friendly visiting, housekeeping help, etc., can assist in prevention of mental difficulties.

In many countries, especially where medical care is provided for the aged through insurance, dental care is also given. It is an aspect of medical care which should not be neglected, as Gil (Spain) has pointed out. A bad set of teeth causes all kinds of disorders and may lead to malnutrition.

### 12. *Training and Education*

The training of personnel who work with the aged, either in institutions or in their own homes, forms a special problem which is now being studied in various countries. In The Netherlands distinction is made among three groups of personnel working in residential or nursing homes: helpers, nursing aides, and staff.

The training of matrons is considered to be of the greatest importance. However, there is a general opinion that all persons who care for the aged should know something of their physiology and psychology. Thus, in many countries, relevant training courses, often of a simple character, are given. Where geriatric units or hospitals exist, nurses and student nurses can learn to nurse the aged. Rudd (Great Britain) wrote a special book on the nursing of the aged. In some countries, as in The Netherlands, much attention is given to the training of special nurses' aides for the aged, young women who nurse the ill and disabled in residential and nursing homes under the supervision of a registered nurse. The question whether the matron of a residential home should be a nurse or a social worker is still unsettled. If she is not a nurse, many concerned with the care of the aged claim she should have at least some basic knowledge of nursing. Only recently The Netherlands Association of Nurses prepared a report on acceptable standards of nursing services for the aged and chronic sick for the Nursing Service Committee of the International Council of Nurses.

Special courses on gerontology for medical men are rare or nonexistent. Some lectures on gerontological problems are given occasionally for medical students and for postgraduates. Interest in gerontology and geriatrics can be stimulated in general practitioners and other medical people by asking them to cooperate in research on the problems of the aged or in programs for their care.

### 13. *Conferences*

Social welfare agencies have recently shown great interest in the problems of the aged. This interest is reflected on an international level. The Technical Assistance Department of the European office of the United Nations organized a two-week conference on the social problems of old age at Wégimont, Belgium, in the fall of 1955. The Eighth International Conference of Social Welfare Services, held at Munich in 1955, and the congresses of the International Federation of Hospitals, especially the Ninth Congress at Lucerne in 1955, devoted much time to these problems.

Furthermore, many national and local conferences have been held to discuss methods and results of practical care for the aged. There was the National Hygiene Congress in France in 1955, and the Sixth Annual Meeting of the Royal Netherlands Medical Association in 1954. Sometimes specific councils or corporations for the aged arrange meetings, as the well-known annual meetings of the National Old People's Welfare Council in Great Britain, the conferences of the Societas Gerontologica Fennica in Finland, etc. At these meetings, evaluations of completed projects as well as future plans are discussed.

### 14. *Discussion*

Although the research cited above is remarkable for the variety in purpose and method, four general considerations remain, which are relevant to the problems involved in making surveys.

First, should a survey in which many subjects are questioned be carried out by one investigator? The advantage of using one investigator is obvious: there is only one standard of rating. The disadvantage is equally obvious: the rating is too one-sided, so that the results may be biassed. The same arguments hold when the survey is carried out by a team of investigators, each of whom performs a separate and different task. When the results of a survey are based on objective criteria, the disadvantage of one investigator or one team of different investigators becomes of minor importance. Examples of this kind are the Sheffield survey of the health situation of the elderly at home by a team under the direction of Hobson and Pemberton, and the survey of all chronically ill old people in South West Frisia (The Netherlands) by Schreuder.

When a great number of forms must be filled out, a one-man survey is simply impossible. In that case it takes more persons to examine, to interrogate, or to interview. The problem then arises of how to interpret the answers and the investigators' findings in the same way. Careful preparation is needed, especially when subjective opinions are involved. Another difficulty which presents itself, perhaps more in older than in younger people, is the fact that the greater the number of investigators, the greater the number of approaches and consequently the greater the chance of refusals. Therefore the team should be instructed on the handling of aged people. This point has been stressed in the sociomedical survey of 3,000 persons aged 65 and over in Groningen, The Netherlands; the investigation of the living conditions and health of 1,389 persons aged 70 or more in Norway; and the Danish National Morbidity Survey. It is, of course, important in every survey of this kind.

The second question is concerned with the carrying-out of the survey itself. Should a survey intended to determine health status be restricted to the asking of questions and not include a medical examination? When interpreting answers to questions, it is necessary to consider not only the subjectivity of the investigator but also the subjectivity of the investigated. Responses are very often colored, though usually not intentionally; an impairment of memory, an emotional attitude, confabulation, and other factors result in unreliable answers. Pagani (Italy) inquired into this matter in a number of institutionalized old persons, and he found that sometimes the history of professional activities, family failure, and other matters differed greatly from the reality. It is not unrealistic to suppose that the history supplied by ill persons will show a number of dubious items. In fact, the failing memory and the tendency for confabulation in old people cause the weakest points in surveys where only questions are put.

It is not surprising that all investigators of the health conditions of the aged, starting with Sheldon in Wolverhampton, stress the importance of a real medical examination. Though the Groningen survey included some short tests to assess the answers somewhat objectively, there remained the necessity of obtaining more accurate data on the health status of the aged population. An attempt to meet this need has been made in some countries, notably in Great Britain and The Netherlands.

In general, we can say that, though physical and mental examinations are preferred, surveys using only verbal answers may be helpful in indicating the major problems. As far as is known to the writer, no large-scale health surveys of aged people have been made in Europe in which only mailed questionnaires have been used. In general, these will yield unsatisfactory results, as older people are even less inclined to fill out questionnaires than are younger adults, as the former have more difficulties in reading and understanding forms. The latter experience was encountered by the author when sending letters of explanation to the aged in the Groningen survey.

However, a questionnaire has been mailed to 50,000 persons of 60 years and over in the French-speaking part of Switzerland by the organization Vert Automne ("Green Fall") to get information on old-age problems of employment and retirement. This questionnaire includes some questions on the general health status, hearing, sight, and so on. As yet no results of this survey are available.

If a medical examination, or some other check on the reliability of the data is regarded as a necessity, must such surveys be performed

by medically trained personnel only? In European countries it is often difficult to find doctors who have time or are willing to make health surveys. Furthermore, until recently, treating old people was rather unpopular with many physicians.

Thus a number of national investigations into the social and the medical conditions of the aged have been performed by others than physicians. If these investigators are nurses, the reports on the health status may still be quite valid. A good example of this is the survey under the direction of Strøm. Generally speaking, however, the actual assistance of general practitioners is necessary to obtain a true picture of the state of health of the aged. The use of interviews and lay investigators may lessen the reliability of the findings. In summary, we may say that nonmedical investigators can be quite useful for collecting material to give an insight into the help needed by old people who are no longer capable of taking care of themselves. If, however, we intend to obtain objective data on the health status, then the investigator must have medical training.

The fourth general consideration concerns itself with the scope of investigations. Do surveys restricted to one town or one region suffice for an insight into a national situation? There have been a great many local or regional surveys on the well-being of the aged. Some were made solely to obtain local information. Others, although aimed at obtaining data of general interest with respect to the old-age problem, had to be limited to one municipality or region.

These restrictions are mostly the result of lack of personnel or funds. Often the very small budgets provided for gerontological research make it difficult to start any investigations on a larger scale. Sociomedical surveys are always expensive in time and money. As gerontology is a rather new discipline, people or organizations are still not much inclined to support sociomedical surveys of the aged on a large scale. Such is, at the moment, the picture in many countries of Europe. There is great interest in collecting all kinds of data of scientific value on behalf of the aged, but the funds are lacking or are sufficient for only a local survey.

Another problem concerns the noncomparability of the data. Even on a national level the results of surveys often cannot be compared. This is partly due to the lack of coordination that exists between social and medical investigators nationally and internationally and partly to different situations in the various countries of Europe. For example, public health administration and programs may differ considerably from one country to another. While the latter circumstance can be changed but gradually, a better mutual understanding and conformity of the definitions ought to be possible within a short time. The conferences of the European section of the Committee on Social Research of the International Association of Gerontology have made a promising start in this direction. In conclusion, local surveys of the conditions of the aged are often of great use in supplementing already existing knowledge of a general nature.

### 15. *Summary*

The main principles in looking after the well-being of the aged, now more or less adopted in Europe, are that the aged have the same rights as the younger age groups to the social and medical services provided by the community and that they should be enabled to live as independently as possible. The medical profession has to contribute to this objective by examining and treating the aged sick as effectively as possible and by cooperating with other agencies in preventing disablement and in restoring those who have been affected to their maximum possible independency.

The idea of keeping the aged independent has led to the introduction or the improvement of pension schemes; to a shift in building policies, from the building of the large institution for the aged to the use of small living-units scattered in small groups among the homes of the younger. A consequence of this shifting is a rapidly growing need for domiciliary services. Here is the crux of the problem in many countries, because of the shortage of women workers. This has led to a second phase in Sweden, the building of old-age homes, although many in that country are aware of the disadvantages of such homes. Nevertheless the general aim is to provide the aged with as many facilities as possible in their homes. In the meantime the lack of good accommodation is so great that hundreds of residential homes are under construction.

Occupational and recreational possibilities are also developing at a rapid rate. Many old peo-

ple prefer to go their own way and not be included in organized programs. This is one of the reasons why in some countries on the continent the system of clubs for the aged is not flourishing.

The public health aspects of the care for the aged are receiving more attention. In most countries, financial circumstances no longer are an important hindrance to medical examination and treatment. Under normal circumstances, the general practitioner is considered the best man to look after the aged. In case of severe diseases or defects, the hospital is the right place to start treatment. Nearly everywhere hospitals are short of beds. This shortage is one of the reasons for setting up geriatric services. The geriatric department in a general hospital or the geriatric hospital forms part of these services. Such services exist in Great Britain, and other countries have also a few geriatric services or are planning to establish them. It is clear to those responsible for the well-being of the aged that rehabilitation constitutes an integral part of proper treatment.

Nursing homes, which fall under the geriatric services where these exist, are also a special problem. Some are run for profit; they may give inadequate treatment; or they may not be subject to effective control. There is still no unanimity of opinion on the question of whether healthy and ill old people should be looked after in one and the same home. The tendency is to provide departments which are at least functionally separated. This separation occurs especially in countries in which two different authorities are responsible for the aged: the social welfare authorities (departments, organizations, and agencies) for the healthy; and health authorities (public health departments, hospital managements) for the ill. Close cooperation between these agencies is always a necessity, as it is between governmental and voluntary organizations in countries where the latter also have a share in the care for the aged. The need for cooperation is stressed again and again in all countries. This fact may indicate that, though much is done on behalf of the older part of the population, it still often happens in an uncoordinated way.

For the aged with mild mental disorders, the idea is to construct special nursing homes with a much more homelike atmosphere, where the accent is on the quickest possible rehabilitation. In some countries such homes can already be found. There is equal need for special departments for the seriously confused aged in the mental hospitals. Various countries have provided for such departments.

Though only the main trends have been indicated, it is hoped that the last part of this review has shown the wholehearted efforts being made by official and private agencies in all countries of Europe to improve the conditions and the state of health of their older citizens.

## BIBLIOGRAPHY


### Belgium

Goossens, J. Les réalisations accomplies en Belgique en vue d'améliorer la situation des personnes âgées. 1. Organismes officiels. In *Les problèmes de la vieillesse.* Tome II. *A l'étranger.* Brussels: C. de Coordination de l'O. I., 1957.

Leplae, C. Résultat de l'Enquête sur la situation individuelle des personnes âgées. In *Les problèmes de la vieillesse.* Tome I. *En Belgique.* Brussels: C. de Coordination de l'O. I., 1958.

Nave, S. de. Les réalisations accomplies en Belgique en vue d'améliorer la situation des personnes âgées. 2. Organismes Privés. In *Les problèmes de la vieillesse.* Tome II. *A l'étranger.* Brussels: C. de Coordination de l'O. I., 1957.

Tuyns, A. Quelques aspects médicaux de l'Enquête sur la situation individuelle des personnes âgées. In *Les problèmes de la vieillesse.* Tome I. *En Belgique.* Brussels: C. de Coordination de l'O. I., 1958.

### Denmark

Danish National Morbidity Survey of 1950. Comunications Nos. 6 & 7. Copenhagen: The Survey, 1956.

Friedberg, R. The Danish National Morbidity Survey. In *The need for cross-national surveys of old age: report of a conference.* Copenhagen: Ministry of Labor and Social Affairs, October, 1956. (Mimeographed)

Ministry of Labor and Social Affairs. *Danish social structure: Welfare of the aged.* Pamphlet No. 5. Copenhagen: The Ministry, 1955.

### Eire

Fleetwood, J. F. A survey of accidents in old age. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

### Finland

Häkkinen, S. Age and road accidents. English summary in *Geron. Yearb. Societas Gerontologica Fennica,* 1954-1955. Helsinki: The Society, 1955.

Societas Gerontologica Fennica. *Yearbooks,* 1954-1955 and 1956-1957 (Also several other reports). Helsinki: The Society.

### France

Delore, P., & Arnaud, P. Motifs d'hospitalisation des malades âgés de plus de 65 ans. *Tech. hosp.,* Paris, 1956, **11,** Nos. 131, 132.

Delore, P., *et al.* Reports of the Ninth Congr. of the Int. Federation of Hospitals. *Tech. hosp.,* Paris, 1956, **11,** Nos. 124, 125. (See also 1953, **8,** No. 93.)

Estève, J., Vannier, J., & Chiquet, A. L'incidence de la maladie des personnes âgées sur l'hospitalisation. *Ed. Revue de l'Assistance Publique à Paris*, 1957.

Gasset, M. A. Les vieillards en établissements hospitaliers. Paper read at the (N. French) Regional Study Days on the Improvement of the Lot of Old People. *Informations sociales*, 1953, **7**, No. 6.

Huet, J. A. La charge constituée par l'hospitalisation des vieillards dans les hôpitaux de Paris. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Huet, J. A. Les maisons de retraite, équipement national. *Bull. Trimestriel du Centre d'Etudes et de Recherches Gérontologiques*, 1955, **4**, No. 3.

Magdelaine, M., & Pequignot, H. Les besoins d'hospitalisation des vieillards et leurs causes. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Treanton, J. R. L'adaptation des personnes âgées à la vie urbaine. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

### Great Britain

Abrams, M. Reflections on survey techniques. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: Livingstone, 1955.

Anderson, W. F. A clinical study of the patients attending a consultative health centre for old people at Rutherglen, Scotland. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: Livingstone, 1955.

Anderson, W. F., & Cowan, N. R. Work and Retirement influences on the health of older men. *Lancet*, 1956, **29**, 1344-1347.

Brown, R. G., McKeown, T., & Whitfield, A. G. W. Medical fitness in relation to employment of men aged 60–69. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Cosin, L. Z. Modern methods in the care of the aged. *J. Roy. Inst. Pub. Health & Hyg.*, 1948, **11**, 122.

De Largey, J. A hospital experiment in social medicine. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Droller, H. Falls and accidents in a random sample of elderly people living at home. In Congress of International Association of Gerontology, *Old Age in the Modern World*. Edinburgh & London: Livingstone, 1955.

Emerson, A. R. Personal communication. October, 1957.

Englefield, M. Nursing old people at home. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Gordon, C., Thomson, J. G., & Emerson, A. R. Domiciliary services for over sixties. *Med. Officer*, 1957, **98**, 19, 35.

Hobson, W., & Pemberton, J. *The Health of the elderly at home*. London: Butterworth, 1955.

Howell, T. H. Basic problems of the aged and chronic sick: report of a survey in Croydon, England. *J. Am. Geriat. Soc.*, 1956, **4**, 224.

Howell, T. H. Old folk who fall. *Practitioner*, 1955, **175**, 56.

Maddison, J., Smith, R. C. F., & Olbrich, O. Factor analysis of the disabilities of the elderly with the aid of an electronic calculator. *Br. J. prev. & soc. Medic.*, 1955, **9**, No. 3.

National Corporation for the Care of Old People. Ninth annual report for the year ended Sept. 30, 1956. London: Nuffield Lodge, Regent's Park.

National Council of Social Service. Over seventy: report of an investigation into the social and economic circumstances of one hundred people of over seventy years of age. London: The Council (26 Bedford Square), 1954.

National Old People's Welfare Council. Progress reports. London: The Council (26 Bedford Square).

Nuffield Foundation. Eleventh and twelfth reports. London: Oxford Univer. Press, 1956 & 1957.

Roberts, J. Report relative to the complete survey of elderly citizens in Salford. Salford: Civic Welfare Offices, 1957.

The safety of old people on the roads. London: Pedestrians' Ass. for Road Safety, 1953.

Sheldon, J. H. The social medicine of old age. London: Oxford Univer. Press, 1948.

Simonds, W. H., & Stewart, H. Old people living in Dorset: a sociomedical survey of private households. *Brit. J. prev. & soc. Med.*, 1954, **8**, 139-146.

Thompson, A. P., Lowe, C. R., & McKeown, T. *The care of the aging and chronic sick*. Edinburgh & London: Livingstone, 1951.

Townsend, P. The extended family and the state. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Townsend, P. *The family life of old people*. London: Routledge & Kegan Paul, 1957.

Warren, M. W. Care of the chronic aged sick. *Lancet*, 1946, **1**, 841-843.

### Hungary

Frigyes, I., & Andor, N. Personal communications. September, 1957.

### Italy

Bonazzi, R., & Ercoli, E. The temporary geriatric colony (with English summary). *Difesa sociale*, 1956, **1**, No. 35.

Cavalieri, M. Adjustment of the aged and alcoholism. Paper read at Seminar on Aging and Social Health, Merano, Italy, July, 1957.

Cavalieri, M. Towards a medicine of the old age homes. *Ass. Geront. Italiana*, n.d. (Mimeographed)

Fiandaca, S., & Trompeo, G. A method of statistical research for a survey on the working capacity of old people. *Med. d. Lavoro*, **46**, 185-190 (Abstract in *Excerpta Med., Section* XVII, 1956, **2**, No. 3.)

Ingegnieros, S., & Nava, C. On the causes of admission to hospitals of aged subjects. *Rassegna Medica*, 1957, **4**, No. 34.

Pagani, A. Notes on the use of interviews with the aged. Paper read at Seminar on Aging and Social Health, Merano, Italy, July, 1957.

### Luxembourg

Kohner, G. Les problèmes de la vieillesse au Grand-Duché de Luxembourg. In *Les problèmes de la vieillesse*. Tome II. *A l'étranger*. Brussels: C. de Coordination de l'O. I., 1957.

THE NETHERLANDS

Bronts, H. J., & van Zonneveld, R. J. The impact of the aged on hospital care in The Netherlands. Paper read at Fourth Int. Geront. Congr., Merano, Italy, 1957.

Bronts, H. J., & van Zonneveld, R. J. A survey into numbers, length of stay, and diagnoses of the aged admitted to a number of hospitals in 1924, 1939, and 1954. *Het Ziekenhuiswezen*, 1957, **30,** 305-314.

Central Bureau of Statistics. Mortality in The Netherlands according to sex, age, and causes of death, 1921-1955 (with English summary and text tables). Zeist: W. de Haan, 1957

Central Bureau of Statistics. Population statistics of The Netherlands, 1938-1954 (with English summary and text tables). Utrecht: W. de Haan, 1957.

Central Bureau of Statistics. Life-tables for The Netherlands, derived from observations made during the period 1950-1952 (with English summary and text tables). Utrecht: W. de Haan, 1954.

Congress on the problem of the aged. Papers and transactions. *Tijdschr. v. Soc. Geneesk.* Reeks No. II Assen: Kon. v. Gorcum & Co., 1957.

Diederich, J. Sociographic investigation into the living conditions of the aged in The Netherlands. Amsterdam: Bureau voor Marktanalyse en sociographisch onderzoek, 1955.

Economic and Social Institute of the Free University of Amsterdam. Investigation of the living conditions, needs, and wishes of the aged in Watergraafsmeer, Amsterdam. Amsterdam: The Institute, 1954. (Mimeographed)

Schreuder, J. T. R. The nursing of chronically ill old people. *Tijdschr. v. Soc. Geneesk.*, 1955, **33,** 119 Blauwe Reeks (Blue Series of the Ass. of Dutch Municipalities), No. 18, The Hague, 1955.

Social Council. Some data on the living conditions of the aged in Rotterdam. Rotterdam: The Council, 1954. (Mimeographed)

van Zonneveld, R. J. Health problems of the aged (with English summary). Assen: Kon. v. Gorcum & Co., 1954.

NORTHERN IRELAND

Adams, G. F., & Cheeseman, E. A. *Old people in Northern Ireland.* Belfast, 1951.

NORWAY

Gaustad, V. Gerontologic progress in Norway. *Geriatrics*, 1955, **10,** 248-251.

Gaustad, V. Scheme for co-ordinated hospital and home services for the aged in Oslo. In Congress of International Association of Gerontology, *Old Age in the Modern World.* Edinburgh & London: Livingstone, 1955.

Labor and the aged. Arbeids markedet, No. 2. Oslo: Arbeidsdirektoratet, 1954.

Marthinsen, A. Homes for the aged and nursing homes in Norway. *Norske Gerontologiske Skrifter,* No. 2. Oslo: De Gamles Helsekomité, 1956.

Norwegian Joint Committee on International Social Policy. The care of the aged in Norway. Oslo: The Committee, 1956.

Strøm, A. An investigation of the living conditions and health of 1,389 persons aged 70 years or more in Norway. *J. Geront.*, 1956, **11,** 178-184.

Strøm, A. Living conditions and health of the aged. *Norske Gerontologiske Skrifter,* No. 2. Oslo: De Gamles Helsekomité, 1956.

SPAIN

Gil, G. Piedrola. Aging of the populations. Colección de folletos, No. 44 Madrid: Dirección General de Sanidad, 1955.

Gil, G. Piedrola. The care of the aged, a new specialty of Public Health. Colección de folletos, No. 39 Madrid: Dirección Generál de Sanidad, 1955.

SWEDEN

The care of the aged. Statensoffentliga udredningar, Social departementet, 1956, **1,** Stockholm, 1956.

Interview-investigation among the old age pensioners in Stockholm: housing and living conditions at the beginning of 1954. Stockholm: Stockholms stads statistika kontor, 1954. (Mimeographed)

SWITZERLAND

Barth, S. Etude de la situation économique et de l'état physique et psychologique de 100 personnes âgées de 60 ans et plus, soignées à la policlinique universitaire de médecine de Genève. Geneva, 1956. (Mimeographed)

Kocherhans, M., Reich, L., & Sigg, E. Die gegenwärtige Lage des pflegebedürftigen chronisch Kranken und Betagten in der Stadt Zurich. Zurich, 1951. (Mimeographed)

Mersing, L. Die Betreuung kranker Menschen im Altersheim. Zurich, 1954. (Mimeographed)

Rossetti, I. Enquète sociale psychologique et biologique sur cent personnes âgées dans deux villages valaisans. Genève, 1952. (Mimeographed)

Roth, J. La situation des personnes âgées en Suisse et les réalisations accomplies en vue d'améliorer leur sort. In *Les problèmes de la vieillesse.* Tome II. *A l'Etranger,* Brussels: C. de Coordination de l'O. I., 1957.

Vettiger, G., Jaffe, A., & Vogt, A. *Alte Menschen im Altersheim.* Basel: Schwabe & Co., 1951.

de Wolff, F. Malades chroniques et âgés dans les établissements Neuchatelois. Geneva, 1956. (Mimeographed)

Zimmerman, H. Die Auswirkungen der Ueberalterung auf den Bettenbedarf für die Pflege alter und chronischer Kanken. Diss., Aarau, 1956.

UNITED NATIONS

European seminar on social services for the aged. Geneva: United Nations, 1956.

WEST GERMANY

Friedhoff, E. Unfall im höheren Lebensalter. *Münch. Med. Wsch.*, 1956, **98,** 1463.

Kotsovsky, D. Altersforschung in Europa. Forthcoming.

YUGOSLAVIA

Domac, V. Personal communications. September, 1957.

# JOURNAL OF GERONTOLOGY

SUPPLEMENT NO. 2

## Symposia

## Presented at the Tenth Annual Meeting of Gerontological Society, Inc.

## Cleveland, November 1 and 2, 1957

PREFACE ..... J. E. BIRREN 1

COLLOIDAL CHANGES IN AGING CELLS ..... L. V. HEILBRUNN 2

HEREDITY AND LONGEVITY IN THE ANIMAL KINGDOM ..... M. ROCKSTEIN 7

DOES CONNECTIVE TISSUE AGE? ..... H. B. BENSUSAN 13

FUNCTIONAL CAPACITIES OF OLDER INDIVIDUALS ..... E. SIMONSON 18

A LOOK AT ATOMIC MEDICINE IN GERIATRICS ..... L. E. FARR 27

THE ASSESSMENT OF MENTAL AND SOCIAL HEALTH IN RELATION TO AGE ..... A. T. WELFORD 33

PRESSURES OF LEISURE ON THE OLDER INDIVIDUAL ..... M. KAPLAN 37

THE IMPACT OF AGING ON THE ECONOMY ..... J. W. MCCONNELL 43

THE IMPACT OF AGING ON SOCIAL INSTITUTIONS ..... C. TIBBITTS 49

ASSESSMENT OF COMMUNITY WELFARE PROGRAMS FOR THE AGED ..... E. WINSTON 54

ASSESSMENT OF SERVICES IN THE VOLUNTARY AGENCY FIELD AS SEEN BY A NATIONAL COMMITTEE ..... G. MATHIASEN 59

ASSESSMENT OF SERVICES IN THE PUBLIC AGENCY FIELD AS SEEN BY A FEDERAL DEPARTMENT ..... W. C. FITCH 63

ASSESSMENT OF COMMUNITY SERVICES AS SEEN BY A COMMUNITY WELFARE COUNCIL ..... M. BARRY 65

ASSESSMENT OF SERVICES FOR THE AGED IN RURAL COMMUNITIES ..... J. H. BRITTON 68

# PREFACE

SUPPLEMENT ISSUE OF THE JOURNAL OF GERONTOLOGY
SYMPOSIA OF THE TENTH ANNUAL MEETING OF THE GERONTOLOGICAL SOCIETY

CLEVELAND, OHIO

NOVEMBER 1 AND 2, 1957

The tenth annual meeting was a special event for the Gerontological Society and the program committee organized the meeting to reflect the progress of the Society and our knowledge of aging. Early meetings of the Society were prone to ask "what is aging?" Recently we have become more aware that it is difficult to discuss the nature of aging without attention to how we measure it. For this reason the symposia were organized around the theme "assessment of aging." The program committee believed that attention to how aging is measured is as important to the biologist investigating a cell particle as it is to the social scientist or to the director of a welfare program who wants to know whether his program is "working."

It might be expected that there would be more cohesiveness in the symposia, but the customs and point of view of the separate professions and disciplines differ. The form of the papers which follow, whether separate or integrated, reflects individual differences of the four sections of the society.

The symposia were outlined by the program committee as a whole, but the detailed planning of the sessions was done by individual members as follows: Dr. Albert Lansing, Biological Sciences; Dr. Joseph T. Freeman, Clinical Medicine; Dr. Wilma Donahue, Psychological and Social Sciences; Miss Florence E. Vickery, Social Welfare.

The program committee has given attention to what is regarded as crucial issues: how do we define aging, how do we measure it, what is the epidemiology of problems of aging, how do we measure the value of therapeutic programs? It may be said that this reflects nothing more than the encouragement of an objective point of view toward aging. But there is something more, the manifest progress from adopting an inquiring and objective point of view over a period of time, in this instance ten years. The publication of the symposia acknowledges ten years of progress; we have a past such that we may anticipate a future.

*James E. Birren*
Program Chairman, 1957

---

Supported by a grant from the Glendorn Foundation.

Entered as second class matter at the post office of St. Louis, Missouri.

Copyright © 1958 by the Gerontological Society, Inc. All rights in the JOURNAL OF GERONTOLOGY are reserved. No part may be reproduced in any form whatsoever without permission in writing from the Journal, except by a reviewer who wishes to quote brief passages in connection with a critical review. Reproduction in whole or in part in digests, in condensations of the literature, in lectures, or in films, or by any other processes or devices is reserved by the Journal.

# BIOLOGICAL SCIENCES SYMPOSIUM

## COLLOIDAL CHANGES IN AGING CELLS*

L. V. HEILBRUNN, Ph.D.

*(From the Zoological Laboratory, University of Pennsylvania, Philadelphia)*

When an animal grows old, there are changes that occur in its cells and its protoplasm. Everybody knows this. There has been no lack of effort to discover what these senescent changes are, since if we knew more about their nature and the mechanism responsible for them, it might be possible to some extent at least to thwart the aging process.

Some of the most careful and patient studies of cellular aging have been made by the cytologists. Using the best and the most modern microscopes they have examined cells in the hope of discovering how old cells differ in appearance from young cells, and in order to find more details of structure, they have used the standard cytologic techniques of fixing, sectioning, and staining. In other words they have compared old dead cells with young dead cells. To some extent they have found differences, but these on the whole have seemed to be of rather minor significance, and there has been no real hint as to the mechanism responsible for the few changes that have been observed.

Perhaps it is not wise to assume that a dead old cell is very different from a dead young cell. Let me consider an analogy—not a very good analogy—but one that may perhaps illustrate my point. Suppose an industrial chemist or physicist were asked to consider the why and wherefore of the aging of paint. Ordinary paint is a colloidal suspension much like protoplasm except that the suspension fluid is oil instead of water. The inquiring industrialist might decide to replace the oil with wax so that he could section the waxy mass and examine the sections under the microscope. Or he might evaporate or distill off the oil and study sections of the pigment that remained. There are procedures similar to those employed by classical microscopists or electron microscopists, but it is hardly likely that old paint would differ very much from fresh paint after the suspension medium had been replaced or removed in one way or another. Thus we might have an explanation of why cytology and electron microscopy have not been overly successful in the study of old age. At any rate another type of approach is certainly worth considering.

What seems to be needed is a comparative study of young living cells and old living cells. The cell is a colloidal engine. It exists and is active because of the nature and the properties of the colloids of which it is composed. If we are to study the aging of any engine—an automobile engine for example—we would not want to grind up or destroy the engines of various ages before we subjected them to examination. Similarly we need to examine the colloidal engines of young and old cells while they are still alive and functioning, and we need to know how the physical properties of these engines change. Techniques for such studies are to some extent now available but they have been little used in the study of senescence. One difficulty is that these techniques are not easy to apply when cells are massed in tissues. Hence at the present time we know very little as to how the protoplasmic colloid changes with advancing age. Indeed we scarcely know if it changes at all.

The protoplasmic colloid is complex and it is sensitive. In regard to its complexity, in most cells, protoplasm is a concentrated suspension of more or less solid material, and it is an emulsion as well. The solid material in the suspension may really be solid films enclosing fluid, that is to say, it may be in the form of minute vacuoles. The suspension medium is itself a colloid, consisting of a solution of assorted huge molecules, all of which are polymers. The protoplasm is sensitive. If we attempt to poke around in it with microneedles, or if we try to squeeze some of it out of the cell, there may be and usually is a rapid and violent change of state, a change of sol to gel. Yet in spite of the complexity of protoplasm and its sensitivity, it is possible to obtain reasonably accurate information as to its physical properties.

This cannot be done by simple visual observation. Whereas the student of colloids or polymers can, simply by tilting a test tube or beaker, note the difference between sol and gel or test the coagulation of a colloid such as

* Aided by a grant from the National Science Foundation.

blood, this is not at all possible in the study of the living colloid. It is, however, rather a simple matter to determine protoplasmic viscosity, at least in some types of cells. This is done by the application of Stokes' law, a law derived about a hundred years ago as a mathematical exercise. Stokes' law is useful in various branches of physics, and it is especially useful in the study of viscosity, for it relates the motion of a sphere through a liquid to the viscosity of the liquid. As the sphere moves, its speed depends on the force driving it through the liquid, and on the viscosity of the liquid. Other factors being equal, the speed of the sphere is inversely proportional to the viscosity.

Now in some cells the granules or inclusions suspended in the protoplasm move under the influence of gravity, but if the granules or inclusions are small and if their specific gravity is not very different from that of the fluid surrounding them, their speed under the influence of gravity may be very slow. Hence it is usually wise to use centrifugal forces, and such forces may be thousands or even hundreds of thousands times gravity. Surprisingly enough, in many cells even great centrifugal forces cause no significant injury, although when some inclusions are heavier and some lighter than the protoplasmic fluid in which they are suspended, the cell may be torn apart. In many cells the granules are so abundant that they completely fill the cell and then there is no possibility of moving them through the rest of the protoplasm. In large cells which can be made to take up magnetic particles, these can be moved by magnetic forces, and Stokes' law can again be applied. However, this method can properly be used only if the cells are sufficiently large so that the engulfed particles are not close to some membrane boundary. Finally, viscosity can be measured by studying Brownian movement, using the formula of Einstein for the speed of such movement or some modification of the Einstein formula.

The various studies that have been made of the viscosity of the protoplasm of plant and animal cells indicate that in many cases the interior of a cell may be fluid, with a viscosity only several times that of water. Such low values for the viscosity have been found for various types of plant cells, for the interior protoplasm of the ameba, for the eggs of sea urchins, worms and clams, for the muscle fibers of the frog, and for nerve fibers of the lobster.

In the various cells that have been studied, there is evidence that not all of the protoplasm is fluid, but that there is an outer rim, or cortex, which is relatively firm and stiff. In eggs of sea urchins and worms, this cortex is very thin; but in some other types of cells it may be relatively thick. In the eggs of the worm Chaetopterus it is possible to determine the rigidity of the cortical protoplasm by determining the amount of centrifugal force necessary to dislodge granules from it. The cortex of the Chaetopterus egg is easily visible after the eggs have been centrifuged with a weak centrifugal force. It is a thin outer rim of the cell containing only a single layer of granules, the so-called cortical granules.

In plant cells, it is ordinarily not possible by visual observation to distinguish the cortical from the interior protoplasm. For this reason, centrifuge measurements of the protoplasmic viscosity of plant cells may be complicated by the fact that it is often not certain whether the measurements concern the properties of the cortex or the interior.

In addition to measurements of viscosity, there is another way of obtaining information as to the colloidal characteristics of the protoplasm. In its colloidal behavior, protoplasm is strangely similar to vertebrate blood. Just as blood clots when it emerges from an artery or vein, so too protoplasm emerging from a cell will clot. In both cases, at least typically, the clot does not form in the absence of calcium ion. In both cases also, a clotting enzyme, which is also a protease, is involved. This clotting reaction of protoplasm can readily be observed in protozoa, in the eggs of sea urchins and other invertebrates, in muscle fibers, and in nerve fibers. In isolated muscle fibers the speed with which the clotting reaction travels along the length of the fiber can readily be measured; and this speed, and the variation of the speed with varying amounts of calcium ion, can give information as to the colloidal characteristics of the protoplasm.

For further discussion of the protoplasmic colloid, its properties and its behavior, recent books by the author may be consulted (4, 5).

Most of the attempts that have been made to determine possible changes in the protoplasmic colloid as cells grow older have been made on plant material. The literature in this field is difficult to interpret. In plant cells generally, it is a simple matter to move granules or inclu-

sions through a cell with a centrifuge. But the inclusions that are easiest to see, the green chloroplasts, may be anchored either to the cortex or to the outer membrane of the cell. Hence the ease with which they can be moved depends in part on the viscosity of the interior protoplasm, and in part also on the extent to which they are anchored in the firm outer regions of the cell. The rigidity of these outer layers is also a factor. Hence the speed with which chloroplasts move through the cell may be an index of the viscosity of the interior protoplasm or of the viscosity or rigidity of the cortex.

As far back as 1901, Miehe (8), in the course of other work, noted—in a single sentence—that when onion leaves were centrifuged, the inclusions in the protoplasm of younger cells were more readily moved than those in older cells. In subsequent literature, although most authors have favored the idea that the viscosity of the protoplasm increases with advancing age, there has been no clear agreement on this point. The most recent worker in the field is Günther (2). In 1957 she not only reported on experiments of her own, but also made a critical review of the older literature. It was her conclusion that with increasing age the interior protoplasm becomes more viscous, but that the cortex (or ectoplasm as she calls it) becomes less viscous. This is exactly the deduction that has been reached in a recent study of animal cells (3).

Concerning the colloidal changes that occur in aging animal cells, there is very little to be said. To the best of my knowledge, the only cells that have been studied are invertebrate egg cells, and whether or not these are strictly comparable to the tissue cell of higher animals is an open question.

The egg cells of the marine worm Chaetopterus constitute especially favorable material. The interior protoplasm is highly fluid, but, as already noted, there is a stiff outer rim or cortex in which a single layer of granules is imbedded. In order to dislodge these cortical granules from the cortex rather high centrifugal forces are necessary. By determining the amount of centrifugal force necesary for such dislodgment, one can obtain a measure of the rigidity of the cortex. Chaetopterus eggs age only slowly if they are allowed to remain in the ovary. But when they are shed from the ovary into sea water, they age very rapidly. So rapidly do they age in sea water that within 24 hours most of them are no longer capable of development.

In the course of 24 hours, the rigidity of the cortex decreases progressively (3). Indeed after 24 hours, the amount of force required to move the granules out of the cortex is only about one-fifth as great as it originally was.

The cortex is a very important part of the cell, as many recent workers have emphasized. In all probability it represents a barrier to the passage of ions. Thus isotope studies indicate that cations can enter the cortex quite rapidly, but that it is difficult for them to pass the cortex and enter the main mass of the protoplasm. The rigidity of the cortex depends on the presence of bound calcium within it. If this calcium is to some extent removed by the immersion of cells in oxalate solutions, then the cortex loses much of its rigidity. At the same time it becomes more permeable, since the impermeability of cell membranes is largely dependent on the presence of calcium in them. Ordinarily the cortex of a cell offers great resistance to the passage of calcium into the cell interior. The protoplasmic colloid of the cell interior is remarkably sensitive to calcium. Thus if the tiniest trace of calcium is injected into a muscle fiber, the fiber will shorten markedly, an indication that the protoplasmic colloid of the muscle cell has been markedly affected. Similar changes occur when calcium enters other cells.

In the egg cells of marine invertebrates, and in many other types of cells as well, the entrance of calcium into the cell interior initiates a clotting reaction. Typically the protoplasm vacuolates so that the entire cell may become full of large vacuoles. In some cells, on the other hand, fibrils appear in the protoplasm as calcium enters. In the case of Chaetopterus eggs, the main mass of the protoplasm becomes filled with vacuoles as the cells age. Hence it can be assumed that the liquefaction of the cortex in the aging cells has favored the entrance of calcium. The vacuolization process in the cell interior implies a clotting or gelation process, that is to say, a marked increase in viscosity.

If it is true that protoplasm generally is avid for calcium, then if the cortex of the cell as it ages permits the entrance of more calcium, such an entrance of calcium might well be an essential factor in the aging process. Certainly, on the whole, the chemical evidence favors the

idea that the calcium content of cells rises with advancing age. This apparently is not caused by an increased avidity of the interior protoplasm for calcium, for the careful studies of Weller (11) demonstrated that as various types of cells in the rat age, homogenates of these old cells showed no greater uptake of calcium than did the homogenates of young cells. But we know from the work of Lansing, Rosenthal, and Kamen (7) that as mice age, their liver cells take up more calcium than do similar cells from young mice. Their results are readily understood on the basis of our experiments with Chaetopterus eggs, since if the cortex of a cell becomes more permeable to calcium, the cell as a whole will tend to suck calcium from the surrounding medium.

What would happen then? Taubmann (9) found that if he perfused a frog with a saline solution deficient in calcium, when he examined the fluid that had been perfused, it contained just as much calcium as ordinary Ringer's fluid, that is to say, approximately as much calcium as the frog blood. Taubmann found also that the calcium had come from the bones. Hence, presumably, if the cells of an animal or a man suck calcium out of the blood, the bones will suffer a loss of calcium. This is exactly what happens in old age.

In old men or old women, decrease in the calcium content of the bones often results in one or the other of two types of disease. Old people commonly suffer from osteoporosis or osteomalacia. In osteoporosis there is less bony material in the bones, for these contain cavities or pores. The result is a tendency for the bones to break. On the other hand, in osteomalacia, the entire bone contains less calcium more or less evenly distributed; instead of becoming more brittle, the bones bend more readily; there may indeed be a condition simulating rickets. Osteoporosis is of frequent occurrence. In 1955, a British author (1) commented on the fact that it is an extremely common condition, and in the same year a South African author (6) called it the commonest of all diseases. American authorities tend to regard osteoporosis as due to endocrine disturbances or to some change in protein metabolism, but it should be noted that it can develop in relatively young people as a result of calcium-deficient diets, and Vinther-Paulsen (10) found that in old people there is a marked correlation between low calcium intake and osteoporosis.

What I have had to say about the colloidal changes in aging cells is certainly not very impressive. I have avoided any discussion of various theories that have been proposed from time to time, and for the most part I have limited myself to the actual factual information, meager as it is.

What we need now is more information concerning the changes that occur in the cells of higher animals. What happens to the protoplasmic colloids of vertebrate tissue cells as they begin to wear out? Can we apply the methods that have been used on isolated cells and cells of lower organisms to the cells of vertebrates, and especially to the cells of mammals?

As yet we have made only a few preliminary studies on two types of animals.* First, in the search for favorable material we examined the liver cells of various fishes, for it is a rather simple matter to determine the age of these animals. Our previous experience had indicated that in one case at least, the granules in the liver cells of vertebrates might be moved by centrifugal force. As noted previously, if there are too many granules in a cell, it is not possible to move them, and liver cells are commonly rather full of granules. In our search for suitable material, we studied all the fishes easily available in the Woods Hole area. The fish that seemed best to suit our needs was the tautog. The liver cells of this fish are relatively large, and in one experiment at least, we were able to move the granules by no very great centrifugal force. We were working hastily in our attempt to make a quick survey of the field, and we only looked at smear preparations. Stained sections would give us better information.

We then turned our attention to cats. It is rather easy to obtain kittens, and we hope also to be able to obtain very old cats of known age. Cat liver cells seem to provide even more favorable material than any of the fish liver cells that we examined. The cells are somewhat larger and our preliminary evidence indicates that the granules in them can indeed be moved.

In addition to studying the liver cells of the cats, we also began studies on muscle fibers. As is well known, the strength of a muscle increases in early life and then declines in old age. These changes may be caused by a number of

* In this work I have had the help of Dr. Walter L. Wilson of the University of Vermont College of Medicine and Mr. Carl Feldherr, who works in my laboratory.

factors. We tried to find out if the properties of the protoplasmic colloid in the cat muscle changed with age. Again our experiments are very preliminary. Indeed we have worked so far with only two cats, and it hardly seems worth while to give the few results that we obtained. This much is clear, however. It is possible to make preparations of isolated muscle fibers from kittens and cats. Those we studied were from the tibialis anticus muscle. We were able to follow the clotting reaction in these muscle fibers and to see how it varied with various concentrations of calcium.

At the present time, all we can say is that in plant cells and in eggs of the worm Chaetopterus, with advancing age the cortical protoplasm becomes more fluid and the interior protoplasm becomes more viscous. We hope in the not too distant future to be able to determine whether similar changes occur in the tissue cells of vertebrates, and we hope also to inquire further into the reasons such changes are initiated. At the present time there are indications that the methods of work developed for simpler cells and simpler organisms may also be applied to the study of aging phenomena in the living cells of mammals.

REFERENCES

1. Cooke, A. M.: Osteoporosis. *Lancet, 268:* 877-882, 929-937, 1955.
2. Günther, E.: Der Einfluss chemischer und physikalischer Faktoren auf die protoplasmatischen Eigenschaften isolierter Elodea-Blätter unter besonderer Berücksichtigung der Zusammenhänge zwischen Wachstumsphase und Plasmaviskosität. *Protoplasma, 48:* 1-52, 1957.
3. Heilbrunn, L. V.: The Aging of Chaetopterus Eggs. *Protoplasma, 46:* 317-321, 1956.
4. Heilbrunn, L. V.: *The Dynamics of Living Protoplasma.* Academic Press, Inc., New York, 1956.
5. Heilbrunn, L. V.: *The Viscosity of Protoplasm.* Springer-Verlag, Vienna, 1958.
6. Jacobson, W. P.: Osteoporosis, Commonest of All Diseases? *South African M. J., 29:* 885-890, 1955.
7. Lansing, A. I., Rosenthal, T. B., and Kamen, M. D.: The Effect of Age on Calcium Binding in Mouse Liver. *Arch. Biochem., 20:* 125-130, 1949.
8. Miehe, H.: Über die Wanderungen des pflanzlichen Zellkernes. *Flora, 88:* 105-142, 1901.
9. Taubmann, G.: Muskelkalk bei Ca-freier Durchströmung. *Arch. exper. Path. u. Pharmakol., 174:* 476-482, 1934.
10. Vinther-Paulsen, N.: Calcium and Phosphorus Intake in Senile Osteoporosis. *Geriatrics, 8:* 76-79, 1953.
11. Weller, H.: Calcium Uptake in Homogenized Organs from Immature, Adult, and Aging Rats. *J. Cell. & Comp. Physiol., 47:* 377-395, 1956.

# HEREDITY AND LONGEVITY IN THE ANIMAL KINGDOM

MORRIS ROCKSTEIN, Ph.D.
*(From the Department of Physiology, New York University College of Medicine, New York)*

As an experimental biologist with a primary interest in the physiology of aging, my interest in the longevity of animals was stimulated by the preparation of tables of longevities for a large number of animal species from man to the lowest invertebrates for the National Research Council-AIBS-sponsored *Handbook of Biological Data* (30). This interest was particularly heightened more recently, during a study of biochemical changes with age in house flies, with the observations of differences in longevity on the basis of sex as well as of certain environmental parameters. In the present review the evidence for the genetic basis of longevity and the environmental influences, which may alter the inherited potential of each animal species or strain to survive, will be considered.

## THE INHERITANCE OF LONGEVITY

The strongest evidence in favor of the concept of the genetic basis for longevity is the persistence of longevity values, whether maximum or average, for each species or strain of animals, as shown in table 1. Of particular interest is the remarkable similarity in average longevities for men and women, respectively, for countries like the United States, Australia, England and Wales, and Sweden. Similar data for the white rat and *Drosophila melanogaster* have been reported by a number of observers in different laboratories in various parts of the world.

A second line of evidence favoring the inheritance of longevity consists of a series of documented vital statistics on human life spans which suggest that longevity is a characteristic of certain families. Thus, in a well-known study by the famed Alexander Graham Bell (2) of the genealogy of the Hyde family (involving over 2200 male and 1800 female descendants of William Hyde), where both parents died at age greater than 80, the average life span was 52.7, or about 20 years greater than for children from parents both of whom died at under 60 years of age (22). Studies by American and Canadian life insurance companies clearly indicate that lower death rates occur for policy holders both of whose parents died at ages above 50 and over 60 (7).

Beeton and Pearson (1) analyzed the records of 1,000 fathers and their sons in Foster's *British Peerage* and of 2,000 pairs of brothers in Burke's *Landed Gentry*. A small but significant positive correlation was observed between the duration of life of son and father. Even in the case of the lowest coefficient of correlation found within the various groups studied, viz. 0.113, the ratio of the coefficient to its probable error was 4.7, which is significant to the extent that the odds are 655 to 1 against this value being due to chance. The paternal-filial longevity influence seemed, however, to be only half as great as that of the brother-brother relationship, for which a coefficient of correlation of 0.260 was found with a ratio of the coefficient to its probable error of 13.0. Thus, the intensity of hereditary influence seen for father and son was exceeded by that for brother and brother by 100%.

It can be argued that children with longer-lived parents enjoy the benefits of parental care, and all that it implies by way of food, shelter, and health care, for a longer period of time. However, most statistics of this kind involve death of the parents at a time when the children would be mature and reasonably expected to have left the protection of their parents. Studies of the fruitfly *Drosophila* by Pearl (22) clearly dispute this argument as well as that of similarity of environment as being important in brother-brother longevity correlations. Thus, by brother-sister matings of short- and long-lived strains of *D. melanogaster*, he isolated 5 distinct strains, with varying average longevities of from 14 to 44 days which bred true for longevity. Moreover, he found that the average longevity for each sex of the mutant strain, vestigial-winged, was consistently lower than for the corresponding sex of the wild strain of the same species (see table 1). In general, this type of evidence is available for strains of the other animal species, especially those employed in the laboratory, for which there are life tables or mortality statistics.

TABLE 1. SEX DIFFERENCES IN AVERAGE LIFE SPAN.

| Animals | | Male | Female | Reference |
|---|---|---|---|---|
| Man Average U. S. A. | (1901) | 48.2 yrs. | 51.1 yrs. | U. N. N. R. (31) |
| | (1951) | 66.6 | 72.6 | |
| Australia | (1948) | 66.1 | 70.6 | |
| England and Wales | (1951) | 65.8 | 70.9 | |
| Sweden | (1945) | 67.1 | 69.7 | |
| India | (1921–1931) | 26.9 | 26.6 | |
| White Rat Average | | 712 days | 773 days | Robertson, Marston, and Walters (25) |
| Average | | 483 | 801 | McCay and associates (20, 21) |
| Maximum | | 927 | 1189 | McCay and associates (20, 21) |
| *Daphnia magna*, Average | 18 C. | 38.6 days | 44.7 days | MacArthur and Bailey (17) |
| | 28 C. | 21.9 | 29.2 | MacArthur and Bailey (17) |
| Black Widow Spider, Average | | 100 days | 271 days | Deevey and Deevey (5) |
| Mealworm, Average | | 60 days | 111 days | Hein (11) |
| *Tribolium confusum*, Average | | 178 days | 199 days | Pearl and associates (23) |
| *Drosophila melanogaster*, Average | | | | |
| Normal | | 31 days | 33 days | Pearl (22), Gowen (8) |
| Vestigal | | 14 | 20 | Pearl and Parker (24) |
| House Fly Average | | 18 days | 30 days | Rockstein (26) |
| Maximum | | 42 | 60 | Rockstein (26) |

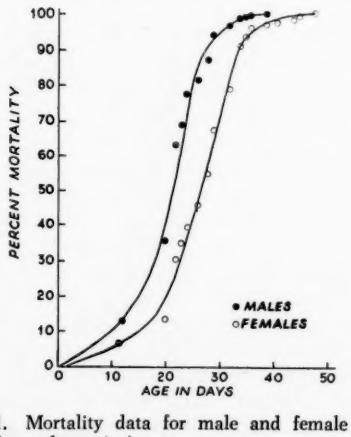


Fig. 1. Mortality data for male and female house flies *(Musca domestica)*.

### *Sex Differences in Longevity*

Another cogent argument in favor of inheritance of longevity is the link of longer life to femaleness in most species studied. Vital statistics reveal a consistently higher mortality rate of males, especially after 25 years of age, for both white and colored individuals in the United States. An analysis by Dublin, Lotka, and Spiegelman (7) of the mortality rate for all male and female subjects for the period 1939-1941 showed the male/female mortality rate to be consistently above 1, indicating a higher male mortality at all ages. Similar data for 1949-1951 have been published by Shurtleff (28). Indeed, human vital statistics, breaking down mortality rates as to specific causes, show that only in a few cases (breast cancer and diabetes, for example) do human males show a lower mortality rate at any adult age (32). Lest the argument be raised that this is not a genetically founded phenomenon, but rather the result of greater hazards to the male in war and in his more active role in society as a breadwinner and all that it connotes, one can refer to table 1 again and see that for a representative variety of vertebrate and invertebrate animal species, male longevity is significantly, often markedly, lower than that of the female. More data of this kind can be found in the publication by Hamilton (9).

Figure 1 shows recent mortality data for male and female house flies *(Musca domestica)* from my own laboratory, a summary of which is seen at the bottom of table 1, in which mortality at any day after the first few days of adult life is always higher in the male. Such data have now been obtained for well over 8,000 flies of a long-inbred strain of house flies (27). Similar differences between male and female longevities in laboratory white rats have also been observed by numerous investigators, including myself, who have employed these animals in biologic and medical research. Thus, there is incontrovertible evidence for the inherent difference in longevity between male and female members of most, if not all, species of animals.

### *Inheritance of Longevity in Twins*

A reasonably conclusive further test of the genetic factor is the difference in longevity between members of identical twin pairs (from the same egg) and fraternal twins (from different eggs). Kallman and Sander (13) gathered data for adult twins over 60 years of age in New York State and the surrounding area from 1945 to the end of 1947. These included 687 males and 907 females. The study showed that for each sex the difference in longevity for members of identical twin pairs was less than half the difference in longevities for members of fraternal twin pairs (age group of first de-

ceased twin partner 60-75 years). A more recent report by Kallman (12) carries this study forward through 1954. Several very interesting detailed case histories of identical twins were cited, such as those of two identical twin sisters, one pursuing the career of farmer's wife and mother of a sizeable family and the other remaining single and earning a living in a large city as a dressmaker, both of whom died within 26 days of one another after each suffered a massive cerebral hemorrhage on the same day. Although one pair of identical twins who died on the same day at 86 years of age was reported, no single case of dizygotic (fraternal) twin pairs was found where the members died closer than 90 days apart. All of the above data firmly indicate the essential, primary role of an hereditary factor (or factors) in the determination of longevity.

Although it is true that the present average life expectancy of the American population, about 68 years for both sexes, is about twice the life expectancy prevailing during the middle ages and three times greater than in Roman times, it is a well-known fact that the maximum longevity has remained virtually unaltered at about 110 years* (3). What is therefore inherited by a species or strain is, in reality, a potential to attain a species maximum longevity under optimal conditions. For a particular era and society with average food and health habits, this usually results in an individual life span which may vary somewhat and probably radically from the species maximum.

## ENVIRONMENTAL FACTORS AFFECTING LONGEVITY

There is a slowly accumulating body of experimental and laboratory observational data concerning the modification in species potential longevity by alteration in specific environmental factors.

### *Diet*

A now-classical study by McCay and associates (20) on the effect of limiting the dietary intake of white rats demonstrated that retardation of growth delayed senescence. A summary of his findings is presented in table 2. Group I was allowed all the food desired and grew normally; groups II and III represent animals

TABLE 2. THE EFFECT OF RESTRICTED FOOD INTAKE AND RESULTANT RETARDED GROWTH UPON LONGEVITY OF WHITE RATS.

| | Group I | | Group II | | Group III | |
|---|---|---|---|---|---|---|
| | Males | Females | Males | Females | Males | Females |
| Average Longevity in Days..... | 483 | 801 | 820 | 775 | 894 | 826 |
| Maximum Longevity in Days..... | 927 | 1189 | 1321 | 1421 | 1306 | 1297 |

Modified from McCay, Crowell, and Maynard (20).

maintained on a restricted diet immediately after weaning and two weeks later, respectively; the average and maximum longevity of the males were markedly increased by this delayed growth due to limiting the daily food (caloric) intake. It therefore seems that, for some species, suspension of growth may be accompanied by delayed senescence. Nevertheless, the exact role of diet is still not clear, since McCay and Crowell (19) were able to double the longevity of trout by the reduction in protein content of the diet from 14 to 10%.

In my laboratory I have maintained newly emerged adult house flies on sugar and water in one study and on sugar, water, and powdered whole milk ("Klim" (26)). Table 3 (26) shows that, whereas the limited (sugar and water) diet had no effect upon the normally lower male average and maximum longevity, in the case of the females these were reduced from 32 to 20 days for average life span and from 60 to about 42 days for the maximum longevity. It is interesting that in this case we are dealing with a species which has completed its growth period within about 24 hours after adult emergence. What is paradoxical is that, unlike the effect of limiting food intake in the case of the white rat, which prolongs the life

TABLE 3. EFFECT OF DIET ON LONGEVITY OF MALE AND FEMALE HOUSE FLIES (26).

| | Diet | | | |
|---|---|---|---|---|
| | Sugar and Water Only | | Supplemented with Powdered, Whole, Bovine Milk* | |
| | Males | Females | Males | Females |
| Average Longevity (Days).. | 15.1 | 19.6 | 16.0 | 31.8 |
| Maximum Longevity (Days) | 35 | 42 | 42 | 60 |

* Borden's product "Klim."

* The reader is referred to an interesting article by Dublin (6) in which he reiterates this oft-mentioned fact that life span of humans continues to remain at 110 years, despite a predicted life expectancy of 70 for men and 76 for women of America in 1970.

span of the males especially, here we were able to reduce the female life span by a rather drastic limitation in protein (rather than caloric intake, because sugar is available in *ad lib.* feeding). That this may be related to a drain on the female protein reserves by egg-laying is a distinct possibility.

It is of interest in this connection that in the adult worker honey bee, Maurizio (18) was able to explain the variation in average longevity between summer worker bees (at 6 to 8 weeks) and overwintering bees (at 6 to 8 months) in terms of diet and the nutritional demands of brood-rearing. Thus, worker bees in a pollen-fed summer colony live as long as 6½ months if the colony is made broodless. Histologic and gross morphologic examination revealed such extended life was associated with a delay in development of the pharyngeal glands (employed in brood-rearing as a source of "royal jelly" or brood food) and of the fat body until 4 to 6 weeks after adult emergence. This is in contrast to the normal summer colony, where these structures attain maximum development by the eighth day, then decline with brood-rearing, and are degenerate by 30 to 40 days. Thus, retarded aging in the worker honey bee is associated with delayed growth and development of certain glands and the food-storage structures, as well as their continued, prolonged maintenance well into old age.

Finally, in the three common species of cockroaches, Haydak (10) found that heavier eaters were the shorter-lived individuals, with this higher food intake being definitely related to higher protein consumption, specifically for the American and Oriental, but not the German, cockroach. It is particularly interesting to note that, in the case of these insects, we are also dealing with animals whose growth period as immature nymphs continues for 6, 10, and over 12 months for the German, Oriental, and American cockroaches, respectively. Reduced diet retards nymphal growth in extending cockroach longevities, in a fashion very much like that seen in the white rat by McCay. There is no conclusive evidence that retardation of growth by restricted dietary intake produces any salutary effect upon human longevity; indeed such effective malnutrition usually shortens life.

*Parental Age and Longevity*

In a pioneer study of the aging process, Lansing (14, 15, 16) found that longevity of the offspring of rotifers *(Philodina citrina)* a complex, aquatic microorganism, depended on the age of the mother at the time of deposition of the parthenogenetic egg. He found particularly that if eggs were obtained from mothers before the mothers attained full growth (by the sixth day), for successive generations, he could increase the life span from 24 to 104 days by the end of 54 generations. Conversely, by selection of eggs after maternal growth had stopped, he could shorten the life of the offspring. Thus, by selecting eggs from parents at the eighth day of parental life, for successive generations, the longevity of the offspring was reduced progressively until the eggs were non-viable by the eighth generation. Selection of eggs at the eleventh day of maternal life resulted in dying off of the descendants by the fifth generation, and selection of eggs at 16 days of maternal life caused dying off of the culture in the third generation. This progressive decline in longevity with increase in the age of the mother at which eggs were collected, moreover, was reversible; by back selection in the converse fashion, i.e., eggs from young mothers, he could reverse the curtailment of longevity. This obviously nongenic cumulative and reversible aging factor, Lansing demonstrated conclusively, was related to cessation of growth in the maternal tissues.

In my own studies with house flies, I attempted to demonstrate the role of maternal age in offspring longevity for bisexual reproduction. In an extensive preliminary study (26), eggs were collected periodically from cages containing parents fed a complete diet and maintained under conditions of constant temperature , humidity, and lighting. Table 4 shows that the 30-day mortality of females increases from 50% for offspring from very young parents (4 to 5 days) to about 90 to 95% for offspring from eggs laid at 27 days of parental age. Interestingly enough, it can be seen that this manipulation of parental age has no effect upon the male offspring's high mortality, which is constant (about 95%) at 30 days of life, regardless of parental age. Many details of this aging (longevity) factor as it affects female house fly longevity are being further explored in my laboratory.

TABLE 4. LONGEVITY OF MALE AND FEMALE HOUSE FLIES. EFFECT OF PARENTAL AGE ON LONGEVITY OF OFFSPRING (26).

| Parental Age (Days) | 30-Day Mortality (%) | |
|---|---|---|
| | Male | Female |
| 4 | 95 | 50 |
| 6 | 93 | 52 |
| 9 | 97 | 70 |
| 15 | 92 | 82 |
| 23 | 97 | 80 |
| 27 | 90 | 92 |

Reprinted from the *Journal of Gerontology, 12:* 255, 1957.

In *Drosophila subobscura*, Comfort (4) was unable to demonstrate a Lansing-like factor for aging related to parental age.

### *Longevity and Marital Status*

A discussion of the possible factors which may alter the inherited potential to survive would not be complete without a brief reference to the relationship of marital status to longevity. In the laboratory there is some limited evidence that mating enhances the longevity of the white rat. For humans, statistics for 1940 (7) and 1949-1951 (29, 32) indicate a higher longevity for married individuals. Thus, for every age group, the mortality rate of men or women (colored or white) was found to be much lower for the married person as opposed to the single, divorced, or widowed.

## SUMMARY

This paper has attempted to highlight the various lines of evidence for the inheritance of longevity of an observational, human vital statistical and experimental biologic nature. These limited findings strongly imply a primary genetic factor, or group of factors, as responsible for the maximum survival potential of each species or strain. The actual life span, furthermore, is the resultant of the interaction of the primary genetic factor and those environmental factors capable of altering the maximum survival potential which has been inherited. In addition to the factors discussed, if one had to conjecture concerning the future of any one species' longevity, including man, another major consideration (not discussed in this presentation) would have to be included; namely, the mutation potential in so far as maximal longevity is concerned.

## REFERENCES

1. Beeton, M., and Pearson, K.: Data for the Problem of Evolution in Man. II. A First Study of the Inheritance of Longevity and the Selective Death Rate in Man. *Proc. Roy. Soc., LXV:* 290-305, 1899.
2. Bell, A. G.: *The Duration of Life and Conditions Associated with Longevity, A Study of the Hyde Genealogy.* Washington, 1918, pp. 57 (privately printed).
3. Bowerman, W. G.: Centenarians. *Tr. Actuarial Soc. Am., 40:* 360-378, 1939.
4. Comfort, A.: Absence of a Lansing Effect in *Drosophila subobscura. Nature, 172:* 83, 1953.
5. Deevey, G., and Deevey, E.: A Life Table for the Black Widow. *Tr. Conn. Acad. Arts & Sc., 36:* 115-134, 1945.
6. Dublin, L. I.: Outlook for Longevity in the United States. *Newsltr. Gerontol. Soc., 4:* 3, June, 1957.
7. Dublin, L. I., Lotka, A. J., and Spiegelman, M.: *Length of Life.* Ronald Press, New York, 1949, pp. 379.
8. Gowen, J. W.: Metabolism as Related to Chromosome Structure and the Duration of Life. *J. Gen. Physiol., 14:* 463-472, 1931.
9. Hamilton, J. B.: The Role of Testicular Secretions as Indicated by the Effects of Castration in Man and by Studies of Pathological Conditions and the Short Lifespan Associated with Maleness. *Recent Prog. Hormone Res., 3:* 257-322, 1948.
10. Haydak, M. H.: Influence of the Protein Level of the Diet on the Longevity of Cockroaches. *Ann. Entomol. Soc. Am., 46:* 547-560, 1953.
11. Hein, S. A.: Studies on Variation in the Mealworm, *Tenebrio molitor. J. Genetics, 10:* 227-264, 1920.
12. Kallmann, F. J.: Twin Data on the Genetics of Ageing. In: *Ciba Foundation Colloquia on Ageing, No. 3:* 131-148, 1957.
13. Kallman, F. J., and Sander G.: Twin Studies on Aging and Longevity. *J. Heredity, 39:* 349-357, 1948.
14. Lansing, A. I.: A Transmissible, Cumulative, and Reversible Factor in Aging. *J. Gerontol., 2:* 228-239, 1947.
15. Lansing, A. I.: Evidence for Aging as a Consequence of Growth Cessation. *Proc. Nat. Acad. Sci., 34:* 304-310, 1948.
16. Lansing, A. I.: A Nongenic Factor in the Longevity of Rotifers. *Ann. N. Y. Acad. Sc., 57:* 455-464, 1954.
17. MacArthur, J., and Bailey, H. T.: Metabolic Activity and Duration of Life. *J. Exper. Zool., 53:* 243-268, 1929.
18. Maurizio, A.: Pollenernährung and Lebensvorgänge bei der Honigbiene *(Apis mellifica L.) Landwirtschaft. Jahrb. der Schweiz, 2:* 115-182, 1954.
19. McCay, C. M., and Crowell, M. F.: Prolonging the Life Span. *Scient. Month., 39:* 405-414, 1934.
20. McCay, C. M., Crowell, M. F., and Maynard, L. A.: The Effect of Retarded Growth upon the Length of Life Span and upon the Ultimate Body Size. *J. Nutrition, 10:* 63-79, 1935.

21. McCay, C. M., Sperling, G., and Barnes, L.: Growth, Ageing, Chronic Diseases, and Life Span in Rats. *Arch. Biochem., 2:* 469-479, 1943.

22. Pearl, R.: *The Biology of Death. Monographs on Experimental Biology.* J. B. Lippincott Co., Philadelphia, 1922, pp. 275.

23. Pearl, R., Miner, R., and Parker, S. R.: Experimental Studies on the Duration of Life. XI. Density of Population and Life Duration in Drosophila. *Am. Naturalist, 61:* 289-318, 1927.

24. Pearl, R., and Parker, S. L.: Experimental Studies on the Duration of Life. IX. New Life Tables for Drosophila. *Am. Naturalist, 58:* 71-82, 1924.

25. Robertson, T., Marston, H. R., and Walters, J. W.: The Influence of Intermittent Starvation and of Intermittent Starvation Plus Nucleic Acid on the Growth and Longevity of the White Mouse. *Australian J. Exper. Biol. & M. Sc., 12:* 33-45, 1934.

26. Rockstein, M.: Longevity of Male and Female House Flies. *J. Gerontol., 12:* 253-256, 1957.

27. Rockstein, M., and Lieberman, H. M.: Survival Curves for Male and Female House Flies. *Nature, 181:* 787-788, 1958.

28. Shurtleff, D.: Mortality and Marital Status. *U. S. Pub. Health Repts, 70:* 248-252, 1955.

29. Shurtleff, D.: Mortality Among the Married. *J. Am. Geriat. Soc., 4:* 654-666, 1956.

30. Spector, W. S. (Ed.): *Handbook of Biological Data. W.A.D.C. Tech. Rept. 56-273,* Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1956, pp. 182-184.

31. *United Nations and National Reports: Demographic Yearbook, 1951.*

32. United States Public Health Service: Mortality from Selected Causes by Marital Status. United States, 1949-1951. *Vital Statistics, Special Reports.* 39 (No. 7): May 8, 1956.

# DOES CONNECTIVE TISSUE AGE?

HOWARD B. BENSUSAN, Ph.D.

*(From the Biochemistry Department, Western Reserve University School of Medicine and The Benjamin Rose Hospital, Cleveland)*

When asked, "does connective tissue age," we have only to look at the marked changes in the character of the skin of the elderly members of our population to find the apparent answer written in the lines and wrinkles imposed by the passing years. Yet, when we investigate these changes, we are hard pressed to describe their nature and cause. The literature is filled with conflicting evidence and interpretations. It is the purpose of this paper to present a summary of our knowledge of the alterations which occur in the components of connective tissue with age. The papers reviewed were chosen to represent the major points of view and results of investigations in this field. In agreement with the philosophy of Lansing (23), we shall limit the discussion to those changes which take place after full growth and development have occurred.

## HISTOLOGIC CHANGES OF DERMIS

Examination of the skin of the hands and face using histologic techniques (11) showed alterations in the elastin network of the dermis beginning in the fourth decade and becoming increasingly apparent with each succeeding decade. The changes commenced in the subpapillary network and progressed downward to the midcutis and then to the subcutis. They appeared at a later time and were not as marked in women.

Ejiri (10) described the alterations as a broadening granular disintegration and as a vitreous and hyaline degeneration of the elastic fibers. He also noted an atrophy and gradual disappearance of the collagen bundles. Collagen, as well as elastin, exhibited regional changes beginning at different ages which ran parallel with time. Ma and Cowdry (28) examined the dermis from a region of the skin which is well protected from exposure to the elements, namely the antecubital area. Differences in the character of the elastic fibers appeared only in specimens taken from the 78-94 year old group. The fibers were thinner and decreased in amount in the subepidermal layer. In the deep elastic fiber layer they were thinner, frailer, wavy, split into fibrils, and decreased in amount.

On the other hand, Dick (9) noted changes beginning in the sixth decade. His samples were taken from the protected portions of the body which included the foot, thigh, forearm, arm, abdomen, and chest. The elastic fibers were shorter and thicker after the sixtieth year. However, such changes were apparent only in a portion of his samples. On the contrary, Hill and Montgomery (16) noted only minor changes which were of doubtful significance in specimens from the axilla, pubis, chest, scalp, and the webs between the toes. They stated that the changes seen by Ejiri were due to the effect of light and the elements on exposed portions of the body.

The leather-like appearance and exaggeration of wrinkles seen in the faces of older farmers and others who spend a large portion of their lives exposed to the sun seems to confirm such an opinion. On the other hand, there does not seem to be any evidence that change would not occur if the hands and face were protected or that these alterations would occur in all areas if the body remained uncovered throughout life. It is possible that the modifications in the character of facial skin with age could be a characteristic inherent in that portion of the body in much the same way as balding is limited to the hair of the scalp.

## CHANGES IN THE MEDIA OF THE GREAT ARTERIES

Only in recent years have there been any quantitative measurements of the connective components of the great arteries. Most of the efforts have been directed to the determination of the elastin and secondarily, to the collagen content of the media. In 1946 Meyers and Lang (29) analyzed the elastin and collagen content of dried, extracted thoracic aorta from specimens ranging in age from 15 to 88 years. They reported that the elastin content, expressed as percentage of dry weight, decreased

significantly until the fourth decade of life, after which there seemed to be no change. The values for collagen increased steadily throughout life. This increase was slight, ranging from mean values of 15.4% for the youngest group to 19.1% for the oldest. The authors claimed such changes to be significant.

Lansing and Rosenthal (26) confirmed the finding that the elastin content of the aorta remains constant in older age groups. Their results showed that the elastin content remained constant after the second decade. They, however, could not claim a significant difference between the 0-20 year group and succeeding groups due to the small number of samples of younger specimens. Additional evidence of the invariability of the relative elastin content of the aorta with age has been provided by Kraemer and Miller (22). These authors were unable to demonstrate a fall in elastin content during the first two or three decades. Thus an apparently clear picture seems to emerge, if one chooses to ignore the slight differences expressed by the above investigators.

The results published by Faber and Møller-Hou (12), however, are in direct contrast to previous findings. These workers showed a marked decrease in elastin of the aorta with age from a value of 35% at 20 years to 22% at 70 years. The relative collagen content, on the other hand, increased from 20% at age 20 to 30.5% at age 70. Both collagen and elastin content of the aorta increased with age when the results were based on total amounts. Thus, although the relative amounts of elastin diminished, the decrease was more than compensated for by the increase in the size of the organ. This indicates that elastin tissue is being laid down throughout life. These contradictory results might well be due to differences in the preparation of the samples. It is impossible without further investigation to determine which results correctly reflect the changes in elastin content of the aorta.

Lansing, Rosenthal, and Alex (27) found that the calcium content of aortic elastin increased sharply in the third decade, reaching a maximum value after the fiftieth year. Later, Lansing and his associates (24, 25, 26) demonstrated that there was a significant change in the amino-acid composition of elastin from the aorta, as well as an increase in the calcium content. These workers found an increase in the relative amounts of the dicarboxylic amino acids, aspartic, and glutamic acid, in the elastin of a group 55-75 years of age, as compared with a group 15-20 years old. However, the situation found in aortic elastin is not a general phenomenon. The elastin of the pulmonary artery showed but little increase in calcium and elastin content and no change in amino-acid composition. These investigators postulate that the increase in dicarboxylic acids might be responsible for the increased calcium content of aortic elastin. They believe that the first step involves the binding of calcium ions to the carboxyl group. Phosphate ions then either remove the calcium with the *in situ* formation of apatites or combine with the free valence of the calcium leaving one phosphate valence to combine with another calcium ion, etc.

Zensser, Butt, and Leonard (34), using electron-diffraction techniques, found that calcium salts could not account for the increased "elastic constants" of aged aortic elastin. Aluminum, and possibly manganese or copper, accounted more satisfactorily for the multiple bonding. However, these latter findings were only correlated with alterations in the elasticity of the media and do not exclude the possible role of the dicarboxylic acids in the formation of unbound apatites. Unfortunately, Zensser and his associates do not give values for what is meant by the term "elastic constants," making it impossible to evaluate their results. Hass (15), in measuring the elastic properties of isolated medial elastin, showed that there was no correlation between age and extensibility or retractility. He claimed a possible correlation between age and tensile strength which did not seem to be justified by the data.

Kirk and Dyrbye (21) analyzed the mucopolysaccharides of the aorta. They found little age difference in total hexosamine, uronic acid, sulfate, and protein content in samples from various age groups. They noted, however, that the ratio of galactosamine to glucosamine was lower in the 60-70 year old group than in samples from children and young adults.

## CHANGES IN COLLAGEN

Workers in determining alterations which take place in collagen with age have made use of its limited number of known physical properties. These include the ability to undergo thermal contraction, swelling, and digestion by the specific enzyme, collagenase. This reviewer believes that it is necessary to point out that

when these workers use the word "collagen," they do not refer to the protein itself but to the protein-mucopolysaccharide complex which occurs in collagen fibers. Thus, procollagen, which is essentially free of polysaccharide, can be reconstituted into collagen fibers which seem to be electronoptically identical with natural fibers (13). It is believed that such fibers are stabilized by the complex formed between them and the ground substance (17). Therefore, many of the results obtained by the workers in this field may be interpreted as effects on the complex.

In 1954, Keech (19) reported the effect of collagenase on extracted, homogenized dermal collagen. The amount digested after 3 hours of incubation was determined from the amount of nitrogen liberated. The author claimed that the amount of collagen digested decreased with increasing age. However, this reviewer, using the data presented, has found no statistical difference between age groups after the first decade. Later, Keech (20) repeated this work, determining the extent of digestion by visual observation. After 3 hours' incubation more was digested in the younger groups. These differences disappeared after 24 hours' incubation, except in the oldest (41-50) group. Little significance can be attached to this work, since there was no attempt to correlate the difference in rate of digestion with fiber size, although the author admits the possible importance of this factor.

A striking change in connective tissue with age was noted by Banfield (1, 2) who observed that the swelling of Achilles tendon in dilute acetic acid increased from birth to 26 years of age. After 26 years, the swelling capacity decreased until 60 years, after which it remained at a constant low level. The author made no attempt to interpret these findings. Another marked difference in fibers from animals of different ages was shown by Verzár (32, 33), who demonstrated that the thermal contraction of rat-tail tendon was far greater in fibers from older animals. This was evidenced by the increase in load necessary for inhibition of contraction, as well as by the greater contraction under a constant load.

In a somewhat similar fashion, Banga, Balo, and Szabo (3, 5, 7) showed that the degree of contraction and relaxation of fibers in 40% KI from the tail tendon of rats of different ages varied markedly. The tendon of young animals contracted but slightly and relaxed rapidly, while those of the oldest animals contracted vigorously but failed to relax. Treatment of old fibers with acid-reducing agents (especially ascorbic acid) caused them to behave like young fibers in 40% KI. Young fibers behaved like old fibers after treatment with oxidizing agents at neutral or alkaline pH. These latter authors believe that the fiber is made up of two proteins, procollagen and metacollagen (4, 5, 7). They claim further (6) that metacollagen is similar to elastin and that collagen is formed only by combination of these two components. The procollagen, according to them, is also complexed with a mucopolysaccharide, this complex stabilizing the metacollagen in a stretched position. They postulate that KI effects the loosening of a procollagen-metacollagen bond and the dissolution of the mucopolysaccharide which causes contraction. Thereafter, the procollagen-metacollagen bonds are broken, bringing the procollagen into solution and causing the metacollagen fiber to relax. Thus, they claim that in old fibers the procollagen-metacollagen bonds are stronger and, therefore, there is no relaxation.

While the results of their experiments are extremely interesting, their interpretation is highly questionable. For example, Veis and Cohen (31) have shown that the acid-insoluble collagen (the metacollagen of Banga and associates) is held together by two types of bonds (A and B) which are stable to acid. The "procollagen" lacks such bonds. It is conceivable that aging is marked by the formation of such bonds in procollagen to form a less-soluble collagen. In other words, "metacollagen" could arise from a single precursor, procollagen, by the formation of these bonds. As collagen is laid down, the fibrils grow thicker by the stepwise addition of fresh procollagen to the matrix already present (18). The older collagen in the center is stabilized by the A and B bonds. The degree of bonding varies from the strongly-bonded matrix to the unbounded periphery which maintains its integrity by hydrogen bonding alone. Under conditions of heat or strong KI solutions hydrogen bonds are ruptured throughout the fibril. This rupture causes the slow liberation of weakly-bonded collagen and the contraction of more firmly bonded collagen. Relaxation might well be accounted for by subsequent hydration of the quantitatively less-bonded younger fibers. This reviewer does

not claim that the latter explanation is a more valid one. It has been proposed in order to point out that there is no single unequivocal interpretation of the data. There is some agreement that stronger bonding does play a part.

A further contribution to the possibility of increased bonding with age has been set forth by Hall (14), who reported that the amount of protein extracted from collagen by borate decreased rapidly until the sixth decade after which the amount extracted was constant at a low level. A fragment which was richer in hydroxyproline (8) appeared in the extract only after longer periods of extraction when the dermal collagen was obtained from older subjects. Hall (14) considers that such extraction might split off portions of the triple helix (30) that make up the collagen molecule and that the bonds ruptured in this manner become more stable with age or are at least more protected by other factors.

The situation today in research involving the aging of connective tissue is similar to that found in all new undertakings. We are in the midst of great confusion resulting from the dearth of sound information. We are guilty of building monuments of theory on foundations riddled by a lack of statistical analyses, a lack of proper criteria for the purity of our materials, and above all, a lack of basic information about the system with which we are dealing. To these sources of weakness we add the confusion of improper standards of nomenclature.

Until we are able to answer the following questions concerning the connective tissue components, we should limit ourselves to exact descriptions under clearly-defined conditions: 1) Are the apparently diverse forms of collagen chemically or physically different? 2) What is the nature and significance of the protein-mucopolysaccharide complex, and is it necessary for the maintenance of the collagen structure? 3) What is the source of elastin? 4) What, if any, is the relationship between collagen and elastin? It is the hope and expectation of this reviewer that these questions will soon be answered. Until such time we cannot answer with any degree of certainty the question, "Does connective tissue age?"

## REFERENCES


1. Banfield, W. G.: The Solubility and Swelling of Collagen in Dilute Acid with Age Variations in Man. *Anat. Record, 114:* 157, 1952.
2. Banfield, W. G.: Age Changes in the Swelling Capacity of the Human Achilles Tendon. *J. Gerontol., 11:* 372, 1956.
3. Banga, I., Balo, J., and Szabo, D.: Contraction and Relaxation of Collagen Fibers. *Nature, 174:* 788-789, 1954.
4. Banga, I., Balo, J., and Szabo, D.: Procollagen as a Component of Collagen Fibers. *Acta Physiol. Acad. Sci. Hung., 9:* 61-72, 1956.
5. Banga, I., Balo, J., and Szabo, D.: The Structure, Aging, and Rejuvenation of Collagen Fibers. *Experientia, Suppl. No. 4:* 28-31, 1956.
6. Banga, I., Balo, J., and Szabo, D.: Metacollagen as the Apparent Elastin. *J. Gerontol., 11:* 242-250, 1956.
7. Banga, I., Balo, J., and Szabo, D.: The Connection Between the Chemical Structure and the Contraction-Relaxation Process of Collagen Fibre. *Proc. 3rd Internat. Congress of Biochem.*, p. 117, 1956.
8. Burton, D., Hall, D. A., Keech, M. K., Reed, R., Saxl, H., Tunbridge, R. E., and Wood M. J.: Apparent Transformation of Collagen Fibrils into Elastin. *Nature, 176:* 966-968, 1955.
9. Dick, J. C.: Observations on the Elastic Tissue of the Skin with a Note on the Reticular Layer at the Junction of the Dermis and Epidermis. *J. Anat., 8:* 201-211, 1947.
10. Ejiri, I.: Studien über die Histologie der menschlichen Haut: III. Mitteilung. Über die Regionären- und Altersunterschiede der verschiedenen Hautelemente mit besonderer Berucksichtigung der Altersveränderung der elastischen Fasern. *J. Dermat. & Urol., 41:* 8-12, 1937.
11. Ejiri, I.: Studien über die Histologie der menschlichen Haut: IV. Mitteilung. Über das Wesen der Altersveränderung der Haut. *J. Dermat. & Urol., 41:* 64-70, 1937.
12. Faber, M., and Møller-Hou, G.: The Human Aorta. V. Collagen and Elastin in the Normal and Hypertensive Aorta. *Acta path. et microbiol. scandinav., 31:* 377-382, 1952.
13. Gross, J., Highberger, J. H., and Schmitt, F. O.: Extraction of Collagen from Connective Tissue by Neutral Salt Solutions. *Proc. Nat. Acad. Sci., 41:* 1-7, 1955.
14. Hall, D. A.: Chemical Studies on the Relation Between Elastin and Collagen. *Experientia, Suppl. No. 4:* 19-27, 1956.
15. Hass, G. M.: Elastic Tissue. III. Relations Between the Structure of the Aging Aorta and the Properties of the Isolated Aortic Elastic Tissue. *Arch. Pathol., 35:* 29-45, 1943.
16. Hill, W. R. and Montgomery, H.: Regional Changes and Changes Caused by Age in the Normal Skin. *J. Invest. Dermat., 3:* 231-245, 1940.
17. Jackson, D. S.: Chondroitin Sulfuric Acid as a Factor in the Stability of Tendon. *Biochem. J., 54:* 638-641, 1953.
18. Jackson, S. F.: Fibrogenesis in Vivo and in Vitro: In: *Nature and Structure of Collagen,* J. T. Randall, ed., Academic Press, Inc., New York, 1953.

19. Keech, M. K.: The Effect of Collagenase on Human Skin Collagen. Comparison of Different Age Groups and Cases with and without "Collagen Disease." *Yale J. Biol. & Med., 26:* 295-306, 1954.
20. Keech, M. K.: Human Skin Collagen from Different Age Groups Before and After Collagenase Digestion. *Ann. Rheumat. Dis., 14:* 19-50, 1955.
21. Kirk, J. E. and Dyrbye, M.: Mucopolysaccharides of Human Arterial Tissue. II. Analysis of Total Isolated Mucopolysaccharide Material. *J. Gerontol., 12:* 23-31, 1957.
22. Kraemer, D. and Miller, H.: Elastin Content of the Albuminoid Fraction of Human Aortas. *Arch. Pathol., 55:* 70-72, 1953.
23. Lansing, A. I.: In: *Cowdry's Problems of Ageing,* 3rd ed., A. I. Lansing, ed., p. viii, Williams and Wilkins, Baltimore, 1952.
24. Lansing, A. I.: Experimental Studies on Atherosclerosis. *Nat. Acad. Sci., Nat. Research Council, Publ.* 338: 50-60, 1954.
25. Lansing, A. I., Roberts E., Ramasarma, G. B., Rosenthal, T. B., and Alex, M.: Changes with Age in Amino Acid Composition of Arterial Elastin. *Proc. Soc. Exper. Biol. & Med., 76:* 714-717, 1951.
26. Lansing, A. I. and Rosenthal, T. B.: Calcium and Elastin in Human Arteriosclerosis. *J. Gerontol., 5:* 112-119, 1950.
27. Lansing, A. I., Rosenthal, T. B., and Alex, M.: Significance of Medial Age Changes in the Human Pulmonary Artery. *J. Gerontol., 5:* 211-215, 1950.
28. Ma, C. K., and Cowdry, E. V.: Ageing of Elastic Tissue in Human Skin. *J. Gerontol., 5:* 203-210, 1950.
29. Meyers, V. C., and Lang, W. W.: Some Chemical Changes in the Human Thoracic Aorta Accompanying the Aging Process. *J. Gerontol., 1:* 441-444, 1946.
30. Ramachandran, G. N.: Structure of Collagen. *Nature, 177:* 710-711, 1956.
31. Veis, A., and Cohen, J.: Nonrandom Disaggregation of Intact Skin Collagen. *J. Am. Chem. Soc., 78:* 6238-6244, 1956.
32. Verzár, F.: Aging of Collagen Fibers. *Experientia, Suppl. No. 4:* 35-41, 1956.
33. Verzár, F.: The Aging of Collagen. *Helvet. physiol. et pharmacol. acta, 14:* 207-221, 1956.
34. Zensser, H. H., Butt, E. M., and Leonard J.: Metal-content Correlation in Aging Aorta. *J. Am. Geriatrics Soc., 5:* 20-26, 1957.

# CLINICAL MEDICINE SYMPOSIUM

## FUNCTIONAL CAPACITIES OF OLDER INDIVIDUALS*

ERNST SIMONSON, M.D.

*(From the Departments of Ophthalmology and Physiological Hygiene, University of Minnesota, Minneapolis)*

Functional capacity involves three fundamental aspects, as illustrated in figure 1: physical fitness, earning capacity, and resistance to disease. They are interrelated, but differ in fundamental characteristics. Research in physiologic gerontology has concentrated on physical fitness, defined mainly as capacity for physical work. A large body of information has been collected, and some of this material will be reviewed later. Tolerance to environmental stresses (temperature, altitude, and perhaps now radiation) is also a component of physical fitness, but has been considered in gerontologic research to a far lesser extent.

Physical fitness may be a desirable goal in itself but its major importance lies in its relationship to the earning capacity, from the social point of view, and to health, from the medical point of view. We will discuss, therefore, fitness of older people in their relationship to earning capacity and health preservation.

Is it possible to improve earning capacity by improving physical fitness? Is the physically more fit individual less likely to be affected by the degenerative diseases of older age? These are important questions, indeed.

The relationship of capacity for physical work to earning power can be discussed quite briefly; it is, for the large majority of industrial and all clerical occupations, negligible. The problem has been solved essentially by the industrial revolution. The process of mechanization has been continuous since about 1800, but was accelerated after the First World War, particularly in Germany. At that time, a fairly large percentage of heavy work was still present, but it was being rapidly diminished. In a cross-sectional comparison of earning capacity in occupations varying in physical effort Ascher (2) found a decline with age of wages of workers in heavy work (wire stretchers) paralleling the decline of muscle strength, while the wages of the fine mechanics were well maintained up to retirement age (fig. 2). For a given type of work (weaving) the wages paid at a piece-rate in a poorly mechanized plant dropped from the 35th year, while those of workers in a fully mechanized plant increased slightly with age, probably reflecting work experience (fig. 3). Today, physical effort has been largely eliminated or reduced to such an extent that it does not affect the earning capacity except for a small minority of jobs. Consequently, there is no physiologic justification for the arbitrary compulsory retirement age of 65 years. It can and probably will be raised with increasing pressure from the aging population.

With the loss in importance of the capacity for strenuous physical work, other physiologic functions have gained in importance, such as vision and motor coordination. The fact that wages in most occupations are well maintained with age does not, of course, preclude deteriorative age trends in these functions. It means only that the demands of industrial performance are below the maximum capacity. As a matter of fact, industrial performance of any kind has to be below the maximum capacity level, otherwise, as war experience in England has shown, it cannot be sustained without interference with health. It is possible, and in fact quite likely, that the older individual works closer to his capacity. This might well affect not so much his actual earnings as his general state of health, as suggested by the increasing rate of sickness absenteeism with age.

Of the various physiologic functions involved in present industrial performance, vision is perhaps the most important. Age trends of visual functions are well known: decrease and final loss of lens accommodation, increasing light absorption of the lens, narrowing of the pupil size, etc. It seems quite likely that the older worker needs a higher illumination level than the younger worker. This has been substantiated by recent investigations of 100 subjects from 17 to 65 years by Guth, Eastman, and McNelis (11), using Luckiesh and Moss' visi-

* Supported, in part, by a grant from the Minnesota Heart Association and, in part, by U.S.P.H.S. grant H-2043.

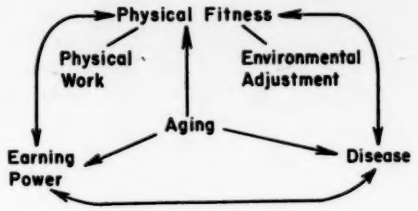


Fig. 1.

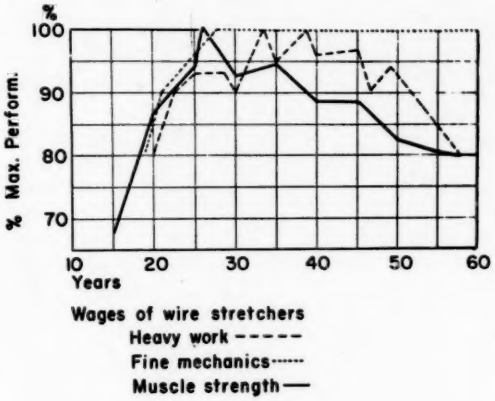


Fig. 2. Effect of age on piece-rate wages of wire stretchers (heavy work), fine mechanics (light muscular work), in German plants, as compared to back muscle strength (2).

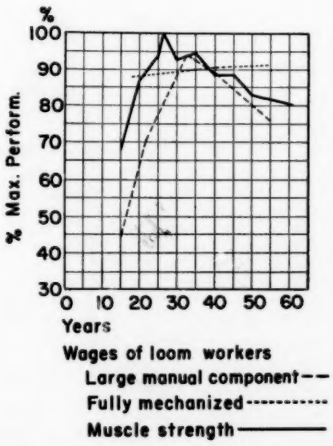


Fig. 3. Effect of age on piece-rate wages of loom workers in a poorly mechanized (considerable muscular effort) and in a fully mechanized German plant (2).

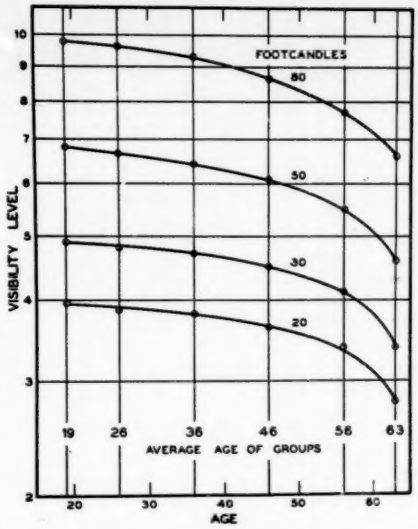


Fig. 4. Decrease of visibility, expressed in score units of Luckiesh and Moss' visibilometer, with age at different levels of illumination (11).

bilometer. Visibility is determined by continuous variation of contrast. Figure 4 shows the decrease of visibility with age at all illumination levels, but also the possibility of compensation by increasing the illumination level. For instance, at 30 foot candles, the visibility is 4.9 at the age of 20 and 3.7 at the age of 60 years, but increase of illumination to 50 foot candles will improve the visibility to 5.0 at the age of 60, equivalent to the value for 20 years at 30 foot candles.

Among the visual functions, the Flicker Fusion Frequency (F.F.F.) is of particular interest, because of its relationship to fatigue (38) and to disease. The F.F.F. is that rate of flicker where the sensation of flicker disappears, and the light patch seems to be steady. This point of fusion can be measured with great accuracy and is related to the time parameter of excitability of the visual pathways, particularly of the visual centers. In previous investigations, it was found to decrease in fatigue, circulatory insufficiency, coronary artery disease, hypothyroidism and hypogonadism, and various nervous disorders (reviewed by Simonson and Brozek, 31). The pronounced age trend of the F.F.F. (37), was confirmed by various authors (5, 7, 20). The decline of cerebral circulation, determined with Kety and Schmidt's method (13), is com-

TABLE 1. CHANGES OF CEREBRAL BLOOD FLOW (CBF; ml./100 Gm./min.) AND FLICKER FUSION FREQUENCY (FFF, flashes/sec.) WITH AGE.

| Function | Average at Age 20 Years | Changes at Age: | | | | |
|---|---|---|---|---|---|---|
| | | 30 | 40 | 50 | 60 | 77 Years |
| CBF*..... | 60.0 | −6 | −10 | −12 | −14 | −16 |
| FFF†..... | 46.0 | −1.3 | − 2.8 | − 4.5 | − 5.8 | − 9.0 |

* Kety (13).
† Average of various authors.

pared with the decrease of the F.F.F. with age, calculated as average from the data of various authors (table 1). The parallel decline indicates probably a causal relationship. In view of the depression of the F.F.F. in fatigue and various stresses, its age trend may well suggest a decreased tolerance of the central nervous system in older people.

With the reduced significance of age trends in physical fitnes for earning capacity, the relationship to health has become one of the most important problems of gerontologic research. As a first approach to this complex problem, we have compared the effect of age and of cardiovascular disease on various types of performance and physiologic functions involved (table 2). The bibliography is representative rather than complete. In general, the effect of normal aging has been studied in a greater number of performance types and the effect of cardiovascular disease in reference to a greater number of metabolic and cardiovascular functions. For some aspects, precise information is missing; in such items, the probable effects are listed, based on the judgment of experienced observers. Even with these limitations, the parallelism of age effects and of cardiovascular disease is striking. Other types of disease show an entirely different profile of interference with the various functions and performance types.

We must conclude, then, that the parallelism is not a coincidence, and that in the general decrease of fitness with age, decrease of cardiovascular capacity and reserve is a major factor. Table 2 shows that different types of performance are affected by age and by cardiovascular disease to a different degree. This is further illustrated by figure 5.

In figure 5 the age trends are compared in three fundamental types of work: endurance in heavy aerobic work near the level of maximum oxygen intake and expressed in terms of work performance (8); performance in maximum anaerobic work, expressed in terms of maximum oxygen intake (9, 27) or performance (36); and moderate aerobic work performed at a steady state of oxygen intake well below the level of maximum intake, and expressed in terms of mechanical efficiency (27). For the purpose of comparison, the age trend in these different types of work is expressed in percentage of the peak performance between 30 and 40 years.

Dawson (8) performed the maximum work possible on the bicycle ergometer during a testing period of 30 minutes at the age of 41, 53, 57, 68, and 71 years. In this type of prolonged work, performance is synonymous with endurance and drops sharply and continuously with age. Dill (9) measured his maximum oxygen

TABLE 2. EFFECT OF OLDER AGE AND HEART DISEASE ON VARIOUS TYPES OF PERFORMANCE AND RELATED PHYSIOLOGIC FUNCTIONS.

| Performance, Physiologic Functions | Age | Cardiovascular Disease |
|---|---|---|
| Motor Coordination, small muscles..... | Unchanged (3, 4, 15, 47) | Probably unchanged |
| larger muscles..... | Well maintained (12) | Probably little changed |
| Speed Repet. Movements, small muscles..... | Slightly decreased (15, 19) | Moderately decreased (45) |
| Muscle Strength..... | Decreased (25, 26, 32) | Probably slightly decreased |
| Endurance, static work..... | Unchanged (36) | Probably little changed |
| Endurance, moderately heavy work..... | Decreased (8) | Decreased (6) |
| Pulse Rate Recovery..... | Delayed (27) | Delayed (33) |
| Oxidative Recovery..... | Delayed (27) | Delayed (33) |
| Respiratory Efficiency..... | Decreased (27) | Decreased (33) |
| Mechanical Efficiency..... | Unchanged (27) | Unchanged or moderately decreased dependant on degree of decompensation to severity of work |
| Speed of initial increase of $O_2$ cons. in work.... | Delayed (27) | Delayed |
| Cardiac Stroke Volume..... | Decreased (17) | Decreased (17) |
| Max. $O_2$ intake..... | Decreased (27) | Decreased (27) |
| Flicker Fusion Frequency..... | Decreased (5, 7, 20, 37) | Decreased (10, 14, 16) |

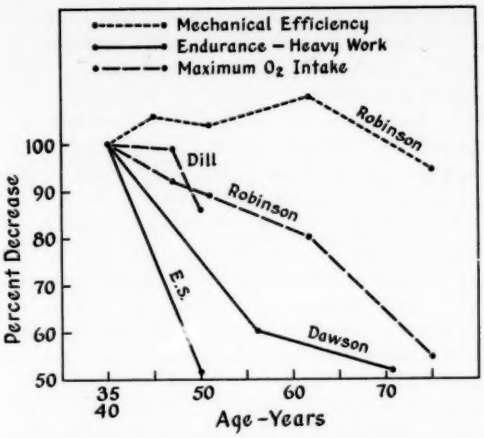


Fig. 5. Effect of age on endurance in heavy aerobic work (8), on the maximum $O_2$ intake in anaerobic work (9, 27), and mechanical efficiency in moderate aerobic work (27), expressed in % of peak performance between 30 and 40 years.

intake in running from 37 to 50 years; his self-observations agree fairly well with Robinson's cross-sectional study. The decline of maximum oxygen intake, determined in short anaerobic work of maximum intensity, is not quite as steep as in Dawson's type of endurance work. We found (36) the endurance of 11 older men with an average age of 53 years in running only half that of 25 young men with an average age of 33 years, which agrees fairly well with Dawson's results. The mechanical efficiency, on the other hand, is not affected until the age of 63 years, and only comparatively little at the age of 75 years.

What are the limiting factors of physical performance as affected by age? One of the most important physiologic functions is the maximum oxygen intake, which determines the limit of anaerobic performance, the maximum level of prolonged aerobic work, and, in general, the cardiovascular reserve. Oxygen transport depends on heart rate, blood oxygen utilization, and cardiac stroke volume. Dill (9) suggested that the inability of older people to raise the heart rate is the limiting factor. However, tachycardias of various types with heart rates equalling or exceeding those in maximum work of young men, are not uncommon in old patients. Vascularization, which determines the peripheral oxygen utilization in skeletal muscle and heart, is probably of major importance. The limiting factors, however, may be not only circulatory functions. In our series (36), the drop of F.F.F. after work was greater in the older men, despite the lower performance. The decreased endurance of older men, therefore, may be in part due to a decreased tolerance of the central nervous system, possibly resulting from the poorer cerebral circulation. The endocrine system seems to be involved in the decline of muscle strength and performance with age. Oral administration of methyl testosterone over a period of several weeks or months, in 6 men over 50 years, resulted in a significant increase in weight lifting and weight holding ability, and muscle strength (40). This was similar to the effect in 4 younger eunuchoids (39) (table 3). In contrast the treatment had no effect on 4 normal young men (28).

Since training increases and age decreases the capacity for physical performance, one might expect that training may delay, or possibly even reverse, the effect of age. The opposite effects of training and age in regard to the changes during exercise have been demonstrated in detail (1, 9, 17, 27, 29); for instance in submaximal work, the cardiac stroke volume is higher in training and lower in older age or disease; the recovery after exercise is faster in training, and slower with age, etc. Of all functions, the maximum oxygen intake is probably the most important one, because it determines not only the capacity for severe anaerobic work, but also the maximum load level for sustained work. This is illustrated in the diagram of figure 6, which was prepared on the basis of available information from various sources. The level of maximum $O_2$ intake is represented by the lower margin of the black areas, their upper margin shows the total $O_2$ requirement. The

TABLE 3. EFFECT OF METHYL TESTOSTERONE ON CHARACTERISTICS RELATED TO WORK PERFORMANCE. MEAN CHANGES. TREATMENT WITH METHYL TESTOSTERONE FOR 6 to 40 WEEKS IN GROUP A (40), FOR 4 WEEKS IN GROUP B (39), FOR 11 WEEKS IN GROUP C (28).

| Group | A | B | C |
|---|---|---|---|
| Item | 6 Older Men Normal but Easily Fatigued | 4 Eunuchoids and Castrates, 21–47 Years Old | 4 Normal Men, 21–30 Years Old |
| Weight lifting | +72.8% | +68.5% | .. |
| Weight holding | +51.3% | +41.1% | .. |
| Muscle strength | +46.8% | +7.7% | 0 |
| Treadmill run | ..... | ..... | 0 |
| Flicker fusion, flashes per second | +6.4 | +3.8 | .. |

black areas above the level of maximum $O_2$ intake represent anaerobic condition with rapid accumulation of waste products and rapid fatigue. The white areas show lower work loads with adequate $O_2$ supply (aerobic condition), and the stippled areas transition from aerobic to anaerobic condition. The maximum $O_2$ intake is highest in trained young men, and lower in untrained young men, older men, and cardiovascular patients, in that order. A heavy load corresponding to an $O_2$ intake of 2.5 L. would still be aerobic work for trained young men, in the transition to anaerobic condition in untrained young men, and entirely anaerobic in older men. Although a load corresponding to 1.5 L. $O_2$ intake could still be performed in aerobic condition (and, therefore, for a prolonged time) by older men, they would be working much closer to their cardiovascular and metabolic reserve, i.e., under greater strain, and would need longer recovery periods.

One of the main effects of training is probably the improved capillarity of skeletal and heart muscle, as shown in experiments on guinea pigs by Petren and Sylven (23) (table 4). Training produced the same percentage increase of heart weight and number of capillaries. Similar results were obtained in skeletal muscle.

The parallelism of muscle hypertrophy and capillarity is a feature of normal training, while in pathologic cardiac hypertrophy the capillary growth stays behind, leading to secondary ventricular ischemia. Increased capillarity would increase the cardiovascular reserve and counteract the effects of arteriosclerotic degeneration. This leads to the question whether older people respond to training as well as younger people do. There is good evidence that training acquired at a younger age can be relatively well maintained; a trained man of 60 years may outperform an untrained man of 40 years.

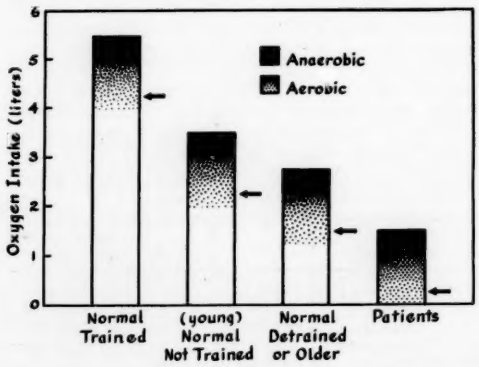


Fig. 6. Working capacity in terms of maximum oxygen intake (margin of black areas) depending on physical condition. Stippled areas show transition from aerobic to anaerobic condition. (Reproduced from Simonson, 34).

Surprisingly enough, no study has yet been made of training in the types of exercise as shown in figure 5 comparing metabolic, respiratory, and circulatory functions in a group of young and of older men, sufficiently large for statistical evaluation. Such series is urgently needed. In the absence of such information, some of my earlier observations may be of interest. In 1926, I studied the rate of repayment of $O_2$ debt of Riesser, 47, and myself, 28, during 4 weeks of training in lifting 12.5-kg. weights (43). Training produced about the same acceleration of the debt payment in both subjects. Twenty years later Berg (4) found a decline of metabolic recovery speed after 20 years of age. Putting both series together, it is reasonable to imply that training will counteract the age trend in this fundamental function. However, it is likely that training must involve considerable muscular effort, if beneficial effects on aging and cardiovascular degeneration are to be expected.

The effect of age and of cardiovascular disease on performance are in the same direction, but are, in general, more profound in disease. Is then, perhaps, cardiovascular degeneration the extreme of a physiologic age trend, not only in regard to performance, but as a general biologic phenomenon? This would be of importance for the relationship between physical fitness, aging, and cardiovascular disease. Particularly, this would be important for possible counteraction of training to effects of aging and cardiovascular degeneration. A beneficial effect of training to prevent or mitigate cardiovascular disease would be more likely in the case of a continuum of age trend and cardiovascular degeneration, than in the case of a new agent producing cardiovascular disease. This is one of the fundamental questions of gerontologic research, and full discussion is not possible within the scope of this paper. Of all cardiovascular diseases, arteriosclerotic degeneration is, by far, the most important. We have tried to obtain evidence for the continuity of age trends and development of atherosclerotic de-

TABLE 4. INCREASE OF RELATIVE HEART WEIGHT AND MUSCLE CAPILLARIES IN TRAINED GUINEA PIGS (Petren and Sylven, 23).

| Animal Group | No. | Capill./sq. mm. | Relative Heart Weight (% Body Weight) |
|---|---|---|---|
| Control..... | 16 | 1920 ± 46 | 0.33 ± 0.008 |
| Trained..... | 30 | 2630 ± 337 | 0.54 ± 0.012 |
| Change..... | ..... | + 35.7 per cent | + 32 per cent |

TABLE 5. CORONARY ARTERY LUMEN (% OF ARTERY AREA) IN 21 CARDIOVASCULAR NORMAL YOUNG (Y) AND 20 OLDER MINNESOTA (O) MEN, AND SELECTED ECG ITEMS IN 47 YOUNG AND 52 OLDER MEN IN MINNESOTA AND IN ITALY.

| Group | | MINNESOTA | | | ITALY† | | | |
|---|---|---|---|---|---|---|---|---|
| | | Coron.* Lumen % | ΣT mm. | Axis° QRS | Axis° T | ΣT mm. | Axis° QRS | Axis° T |
| Y | M | 44.52 | 7.46 | 68.87 | 44.85 | 5.35 | 42.83 | 35.04 |
| | S. D. | 7.88 | 2.01 | 17.44 | 19.92 | 2.70 | 30.76 | 20.86 |
| O | M | 31.50 | 5.16 | 45.19 | 26.65 | 4.94 | 35.56 | 34.85 |
| | S. D. | 8.10 | 1.67 | 29.97 | 23.66 | 2.15 | 26.10 | 21.77 |
| O-Y | △ | −13.02 | − 2.30 | −23.68 | −18.20 | − 0.41 | − 7.27 | − 0.19 |
| | t | 5.2** | 6.2** | 4.7** | 4.2** | 0.8 | 1.3 | 0.04 |
| Percentage | | −29.3 | −30.9 | ..... | ..... | − 7.6 | ..... | ..... |

* Lober (18).

† Collected by A. Keys.

M = means; S. D. = standard deviations; △ = means difference between age groups (O-Y) and their statistical significance = t.

TABLE 6. MEAN (M) AND STANDARD DEVIATIONS (S.D.) OF SELECTED ECG ITEMS IN 15 PATIENTS (P) WITH ANGINA PECTORIS IN NORMAL RESTING ECG, COMPARED TO 233 NORMAL OLDER MEN (O).

| Group | | $R_2$ | $T_1$ | $T_2$ | ΣT | Axis° QRS | Axis° T | $T\text{-}V_4$ |
|---|---|---|---|---|---|---|---|---|
| P | M | 7.05 | 1.71 | 1.46 | 3.93 | 11.00 | 16.67 | 3.61 |
| | S. D. | 3.79 | 0.87 | 0.77 | 1.35 | 29.86 | 33.13 | 2.24 |
| O | M | 7.75 | 2.01 | 2.26 | 5.20 | 37.77 | 32.87 | 7.08 |
| | S. D. | 3.16 | 0.89 | 0.95 | 1.74 | 34.67 | 23.96 | 2.49 |
| P-O | △ | − 0.70 | − 0.30 | − 0.80 | − 1.27 | −26.77 | −16.20 | − 3.47 |
| | t | 0.82 | 1.27 | 3.19 | 2.77 | 2.92 | 2.54 | 1.71 |
| | P | 0.42 | 0.21 | 0.002 | 0.006 | 0.005 | 0.015 | 0.09 |

generation in regard to the ECG, peripheral pulse, and aortic pulse wave velocity.

Figure 7 shows the typical ECG of a young man of 22 years (S. M.), and of an older man of 51 years (C. H.). The ECG's were selected to match, as closely as possible, the *average* P-R and QRS interval, P, QRS, and T amplitude, and QRS and T axes for each age group of 159 and 233 men, respectively (35). In order to find these truly representative individuals, 500 ECG's were scanned; obviously, an individual average in not only one but in several items, is very rare. The typical age trends are a shorter P-R interval, lower amplitudes, and axes deviations to the left. That the ECG age trends reflect the sclerotic changes of the coronary arteries (decrease of lumen, and increase of wall thickness) is supported by comparison of electrocardiographic age trends in Minnesota and in Italy. Incidence of advanced coronary sclerosis and of coronary disease is much lower in Italy. Out of a larger number of electrocardiographic items measured, table 5 shows the age differences of three selected items (ΣT or sum of T amplitude in the 3 standard leads; QRS axis, and T axis) in 47 young and 52 older men in Minnesota and in Italy (30).*

Both electrocardiographic groups were matched in reference to body weight distribution and age. In contrast to the highly significant age differences in the Minnesota men which parallel age changes of coronary arteries

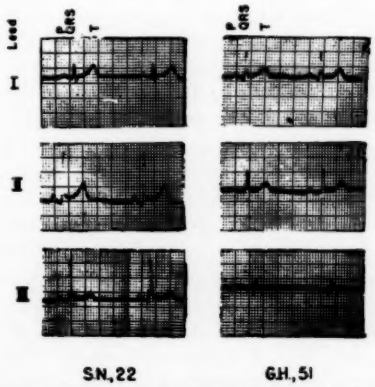


Fig. 7. ECG of a young man (S. M., 22 years) and of an older man (C. H., 51 years), representative for the means of their age groups. (Reproduced from Simonson, 35).

* The data for the Italian sample were collected by A. Keys.

in Lober's autopsy material in Minnesota population (18), age differences in the Italian sample are very small, although in the same direction, and not statistically significant. It seems reasonable to suggest that the electrocardiographic trends found in Minnesota are caused by progressive coronary atherosclerosis.

In order to acquire more specific information, we compared selected items in the resting electrocardiogram of 233 older, clinically healthy men and in 15 angina pectoris patients with normal resting electrocardiogram, but with abnormal response to exercise, i.e., in the initial phase of the disease (table 6). All changes in the group of patients are in the direction of normal age trends, and are statistically significant in 4 out of 7 items studied. In another item ($T\text{-}V_4$), the difference approaches statistical significance. The continuity of age trends and the development of coronary artery disease can be demonstrated only in the early phase of the disease. Later, local ischemia patterns dominate and obscure this relationship.

Peripheral circulation was studied by analysis of the contour of the toe pulse, photoelectrically recorded (42). Peripheral circulation is one of the fundamental functions determining the capacity for physical work. The speed of the upstroke and downstroke was measured and compared in 159 young men (Y), 267 older men (O), 55 patients with arterial hypertension (H) and 34 patients with peripheral vascular disease (PVD). There were statistically highly significant age trends in all items, but we limit the presentation to the relative crest time in p r cent of cycle length (table 7). The changes in the groups of patients are in the same direction and appear as an extreme exaggeration of "normal" physiologic age trends. The continuum of the increase of the blood pressure with age and essential hypertension is well recognized (24).

Recently Nakagawa and I (21) compared the age trend of the aortic pulse wave velocity in healthy men and normotensive patients with coronary artery disease. The pulse wave velocity was determined between the second right parasternal intercostal space and the femoral artery by means of impedance plethysmography.* Figure 8 shows the acceleration of normal physiologic age trends in coronary patients, probably due to aortic atherosclerosis, to be about 10 years. The evidence strongly supports the concept that arteriosclerotic cardiovascular disease is the extreme of physiologic age trends.

TABLE 7. MEANS (M) AND STANDARD DEVIATIONS (S. D.) OF RELATIVE CREST TIME (% of Cycle) OF 159 YOUNG MEN (Y), 267 OLDER MEN (O), 55 PATIENTS WITH ARTERIAL HYPERTENSION (H), AND 34 PATIENTS WITH PERIPHERAL VASCULAR DISEASE (PVD) (42).

| Group | Relative Crest Time (% Cycle) | |
|---|---|---|
| | M | S. D. |
| Y | 14.2 | 3.2 |
| O | 15.8 | 2.9 |
| H | 16.6 | 4.0 |
| PVD | 26.4 | 5.5 |
| **Statistical Significance** | | |
| | t | P |
| Y vs. O | 5.28 | .0001 |
| H vs. O | 1.54 | n. s. |
| PVD vs. O | 17.27 | .0001 |

I mentioned in the introduction that physical fitness research has concentrated largely on capacity for physical work. Other physiologic stresses, however, are also of importance. As an example, figure 9 shows results of recent investigations of circulatory adjustment to positional changes by Nakagawa and myself (21). The extracranial circulation of 26 younger and 26 older men was studied by means of impedance plethysmography during tilting up (45°) and down (15°). Figure 9 shows typical tracings of a young man and of an older man. The decrease of the amplitude in tilting up, and particularly the increase of amplitude in tilting down, is much more pronounced in the older men. The difference of the group means was statistically highly significant and reveals a significant impairment of an important circulatory adjustment in the older group. More research in this area is obviously needed.

One might expect, perhaps, that beneficial effects of training may show up in the mortality from cardiovascular disease. There are, of course, many factors which affect the mortality in addition to the potential effects of training, such as diet, race, trends of disease, competing non-circulatory mortality, etc. Morris (22) found in a large British material the mortality from coronary heart disease significantly lower in occupations involving muscular effort than

* The impedance plethysmograph was constructed by O. H. Schmitt.

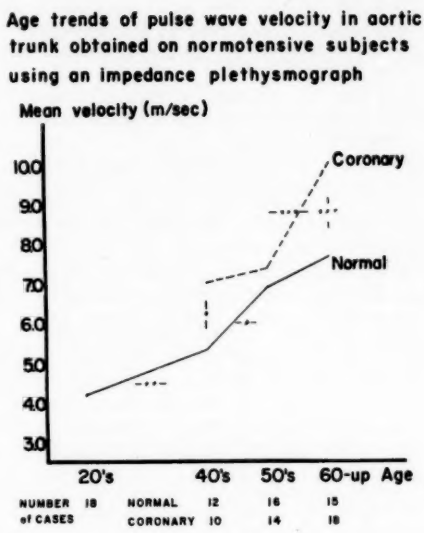


Fig. 8. Statistical significance of aortic pulse wave velocity between age groups is shown by horizontal lines, and between patients and normal subjects at the same age by vertical lines. * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$.

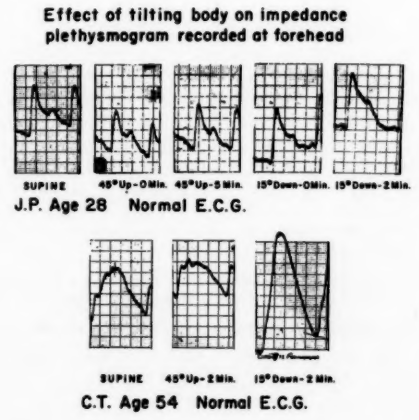


Fig. 9. Impedance plethysmographic records of an extracranial volume pulse in supine position, tilted up 45°, and tilted down 15°, of a young man (J. P.) and an older man (C. T.).

in sedentary occupations, but this was not confirmed in American material (46).

Perhaps, the incidence of ischemic heart disease in occupational groups with different degrees of physical work may be more conclusive, and such series are now in progress on railroad workers at the Laboratory of Physiological Hygiene, under the direction of H. L. Taylor.

## REFERENCES

1. Abramson, D. I., Keeton, R. W., Cole, W. H., Mitchell, H. H. Dyniewicz, J. M., Gephardt, M. C., Presley, S. J., and Keaney, W. R.: Value of Blood and Urine Lactate Response to Physical Effort as an Index of Physical Fitness. *J. Clin. Invest., 28:* pp. 767, 1949.
2. Ascher, L.: quoted from E. Simonson: Arbeitsphysiologie, In: *Handb. d. normal. u. pathol. Physiol.* (Bethe-Bergmann) *15:* 519-586, 1930.
3. Ascher, L., and Baumgarten, P.: Beiträge zur Kenntnis der körperlichen Beschaffenheit der arbeitenden Bevölkerung. *Veröff. Med. Verwalt., 19:* 487, 1925.
4. Berg, W. E.: Individual Differences in Respiratory Gas Exchange During Recovery from Moderate Exercise. *Am. J. Physiol., 149:* 597-610, 1947.
5. Brozek, J., and Keys, A.: Changes in Flicker Fusion Frequency with Age. *J. Consulting Psychol., 9:* 87-90, 1945.
6. Burke, W. E., Tuttle, W. W., Thompson, C. W., Janney, D. C., and Weber, R. J.: The Relation of Grip Strength and Grip Strength Endurance to Age. *J. Appl. Physiol., 5:* 628-630, 1953.
7. Coppinger, N. W.: The Relationship Between Critical Flicker Frequency and Chronologic Age for Varying Levels of Stimulus Brightness. *J. Gerontol., 10:* 48-52, 1955.
8. Dawson, P. M., and Hellebrandt, F. A.: The Influence of Aging in Man upon His Capacity for Physical Work and upon His Cardiovascular Responses to Exercise. *Am. J. Physiol., 143:* 420-427, 1945.
9. Dill, D. B.: Effects of Physical Strain and High Altitude on Heart and Circulation. *Am. Heart J., 23:* 441-454, 1942.
10. Enzer, N., Simonson, E., and Blankstein, S. S.: Fatigue of Patients with Circulatory Insufficiency, Investigated by Means of the Fusion Frequency of Flicker. *Ann. Int. Med., 16:* 701-707, 1942.
11. Guth, S. K., Eastman, A. A., and McNelis, J. F.: *Lighting Requirements for Older Workers.* Lamp Division, General Electric Co., Preprint No. 22, 1957, 16 pp.
12. Jokl, E.: *Alter und Leistung.* Springer-Verlag, Berlin, 1944, 75 pp.
13. Kety, S. S.: Changes in Cerebral Circulation and Oxygen Consumption Which Accompany Maturation and Aging. In: *Biochemistry of the Developing Nervous System* (H. Waelsch). Academic Press, Inc., New York, 1955, pp. 208-217.

14. Keys, A., and Simonson, E.: The Flicker Fusion Frequency and Its Response to Nitroglycerin in Normal Subjects and in Patients with Cardiovascular Disease. *Circulation, 5:* 215-224, 1952.

15. Kossoris, M. D.: Relation of Age to Industrial Injuries. *Monthly Labor Rev., 51:* 789-799, 1940.

16. Krasno, L. R., and Ivy, A. C.: Response of the Flicker Fusion Threshold to Nitroglycerin and Its Potential Value in the Diagnosis, Prognosis, and Therapy of Subclinical Cardiovascular Disease. *Circulation, 1:* 1267-1276, 1950.

17. Landowne, M., Brandfonbrener, M., and Shock, N. W.: The Relation of Age to Certain Measures of Performance of the Heart and Circulation. *Circulation, 12:* 567-576, 1955.

18. Lober, P. H.: Pathogenesis of Coronary Sclerosis. *Arch. Path., 55:* 357-383, 1953.

19. Miles, W. R.: Performance in Relation to Age. *Pub. Health Rep., Suppl. No. 168:* 34 pp., 1943.

20. Misiak, H.: Age and Sex Differences in Critical Flicker Frequency. *J. Exper. Psychol., 37:* 318-332, 1947.

21. Nakagawa, and Simonson, E.: Unpublished data.

22. Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., and Parks, J. W.: Coronary Heart Disease and Physical Activity of Work. *Lancet, 2:* 1053-1057, 1111-1120, 1953.

23. Petren, T., and Sylven, B.: Weitere Untersuchungen über den Einfluss des Trainings auf die Kapillarisierung der Herzmuskulatur. *Morphol. Jahrb., 80:* 439-444, 1937.

24. Pickering, G. W.: *High Blood Pressure.* J. & A. Churchill, London, 1955, pp. 547.

25. Quetelet, A.: Sur l'Homme et le Developpement de ses Facultés. L. Hauman and Cie., Brussels, 1836.

26. Rejs, J. H. O.: Über die Veränderung der Kraft während der Bewegung. *Arch. ges. Physiol., 191:* 234-257, 1921.

27. Robinson, S.: Experimental Studies of Physical Fitness in Relation to Age. *Arbeitsphysiologie, 10:* 251-323, 1938.

28. Samuels, L. T., Henschel, A. F., and Keys, A.: Influence of Methyltestosterone on Muscular Work and Creatin Metabolism in Normal Young Men. *J. Clin. Endocrinol., 2:* 649-654, 1942.

29. Simonson, E.: Physical Fitness and Work Capacity of Older Men. *Geriatrics. 2:* 110-119, 1947.

30. Simonson, E.: The Electrocardiogram in Coronary Heart Disease. *Minnesota Med. 38:* 871-873, 1955.

31. Simonson, E., and Brozek, J.: Flicker Fusion Frequency. *Physiol. Rev., 32:* 349-378, 1952.

32. Simonson, E., and Enzer, N.: The State of Motor Centers in Circulatory Insufficiency. *Arch. Int. Med., 68:* 498-512, 1941.

33. Simonson, E., and Enzer, N.: Physiology of Muscular Exercise and Fatigue in Disease. *Medicine, 21:* 346-419, 1942.

34. Simonson, E.: Changes in Physical Fitness and Cardiovascular Functions with Age. *Geriatrics, 12:* 28-39, 1957.

35. Simonson, E.: The Normal Variability of the Electrocardiogram as a Basis for Differentiation Between "Normal" and "Abnormal" in Clinical Electrocardiography. *Am. Heart J., 55:* 80-103, 1958.

36. Simonson, E., Enzer, N., and Benton, R. W.: The Influence of Muscular Work and Fatigue on the State of the Central Nervous System. *J. Lab. & Clin. Med., 28:* 1555-1567, 1943.

37. Simonson, E., Enzer, N., and Blankstein, S.: Influence of Age on the Fusion Frequency of Flicker. *J. Exper. Psychol., 29:* 252-255, 1941.

38. Simonson, E., Enzer, N., and Blankstein, S.: Measurement of Fusion Frequency of Flicker as a Test of Fatigue of the Central Nervous System; Observations on Laboratory Technicians and Office Workers. *J. Indust. Hyg. & Toxicol., 23:* 83-89, 1941.

39. Simonson, E., Kearns, W. M., and Enzer, N.: Effect of Oral Administration of Methyltestosterone on Fatigue of Eunuchoids and Castrates. *Endocrinology, 28:* 506-512, 1941.

40. Simonson, E., Kearns, W. N., and Enzer, N.: Effect of Methyltestosterone Treatment on Muscular Performance and the Central Nervous System of Older Men. *J. Clin. Endocrinol., 4:* 528-534, 1944.

41. Simonson, E., and Keys, A.: The Effect of Age and Body Weight on the Electrocardiogram of Healthy Men. *Circulation, 6:* 749-761, 1952.

42. Simonson, E., Koff, S., and Keys, A.: Contour of the Toe Pulse, Reactive Hyperemia, and Pulse Transmission Velocity: Group and Repeat Variability, Effect of Age, Exercise, and Disease. *Am. Heart J., 50:* 260-279, 1955.

43. Simonson, E., and Riesser, O.: Zur Physiologie der Uebung. *Arch. ges. Physiol., 215:* 752-767, 1927.

44. Simonson, E., and Winchell, P.: Effect of High Carbon Dioxide and of Low Oxygen Concentration on Fusion Frequency of Flicker. *J. Appl. Physiol., 3:* 637-641, 1951.

45. Smith, K. R.: Age and Performance in a Repetitive Manual Task. *J. Appl. Psychol., 22:* 295-306, 1938.

46. Stamler, J. (Personal communication, in press)

47. Stieglitz, E. J.: Aging as Industrial Health Program. *J.A.M.A., 116:* 1383-1387, 1941.

# A LOOK AT ATOMIC MEDICINE IN GERIATRICS

LEE E. FARR, M.D.
*(Medical Director, Brookhaven National Laboratory, Upton, Long Island, New York)*

Census reports show that between 1900 and 1955 there has been a doubling of the percentage of our population aged 65 years and over from 4.1% to 8.5%. In the same interval the population has increased to the extent that while the number of people aged 65 and over in 1900 was 3.5 million, by 1955 the figure had risen to 12 million, almost a four-fold gain; and by 1975 it is estimated that this number will increase to nearly 21 million, or 9.4% of the population. These figures attest to the importance of this segment of our people.

It is a truism to state that the requirements for medical care of older people are different from the requirements of middle-aged and younger people. They are different intrinsically since predictable changes in body constituents are regularly and continuously occurring. While this has clearly been recognized in relation to physical growth of childhood, it has been overlooked in relation to older ages. There are two main factors concerning medicine in the older person; one is this constant chronologic development and the other is age dependent or age associated disease. Frequently there is a failure to distinguish between these two related aspects of medical care in maturity. Illness of old age may be a culmination of a gradual deterioration in function having its origin many years previously and progressing inexorably until a state of helplessness and complete dependency is created to be followed ultimately by death. The same end may also be brought about by a rapidly striking disease of vital organ systems. It is with these problems of disease-induced helplessness and dependency as well as alleviation of suffering that we concern ourselves in this discussion.

It is necessary that clear distinctions be made between diseases of older ages and the involutional changes of age itself. Bone composition changes regularly with time, and thus this alteration is a reflection of age, not disease (28). In other organ systems similar changes may and do occur with time. The present discussion is not addressed to efforts looking toward the postponement of phenomena of age. It must be clearly established that the assigned causes of death in the aged are to be constantly reevaluated since the recorded causes will be weighted for disease etiology favored by our medical habits and fashions, biased by our diagnostic systems, and profoundly influenced by our ignorance of many normal physiologic changes. Medical successes in overcoming the hazards of infectious diseases, in establishing the causes of and control of diseases resulting from dietary insufficiencies, avitaminoses, pernicious and iron deficiency anemias, in reducing the risk of surgery so that many disorders of middle-age can be met satisfactorily by removing the affected part and in providing adequate corrective therapy for some intrinsic diseases, such as diabetes mellitus, leads us to the hope that as we can define the abnormal changes occurring in older people, we may, by application of new techniques available to us, be able to bring a measure of control to these disease states.

In prior times the causes of most diseases were external agents, bacteria and viruses, or food deficiencies, so that a measure of control of the environment was effective in markedly reducing the incidence of disease. Today we must face the problem of production of new diseases from environmental contamination resulting from insecticides, plant and grass controllers, industrial wastes, and also radioactive fallout. The effects of these agents on populations must be ascertained as well as upon individuals. This necessity to be concerned medically with a population as well as the individuals composing that group is one of the newer developments of medical responsibilities today. It is of greatest importance in relation to populations of mature persons.

In the study of the individual affected with disease caused by an external agent, it was relatively easy to produce an experimental counterpart so that control measures could be varied and evaluated under designed experimental conditions. In the dietary insufficiencies, the problem was more complex because of the wide occurrence of vitamins and the broad spectrum of foods eaten. Yet again, not only the causative lack, but also, in many instances, much of the mechanism of the disorder was discovered.

Thereby effective measures to prevent, control, and correct could be instituted. Where localized disease exists, surgery often has provided adequate control measures, although here in many instances little progress seems to have been made in developing an understanding of the causative factors.

In the so-called degenerative diseases one is dealing with widespread physiologic changes, usually minor quantitatively and not subject to any of the approaches to control which have proved so successful in other instances. In diabetes mellitus perhaps is found one outstanding success wherein by replacement therapy a person is enabled to carry on a normal life. With the very recent advances in isolation and synthesis of hormones, replacement therapy has become more important and more available to the general population. However, many of these disorders are no longer of great concern to the older population since the challenge of the hormonal disorder must long since have been met. The cumulative degenerative disorder of indeterminate progression, probably of long standing, comes to the fore as the most important cause of disability and death with, in this instance, disability perhaps of greater import to the individual and his family than death. If, therefore, successful efforts result in a prolonging of the individual's, not the group's, life span there must be provided a means of controlling these diseases, for a life of severe disability is scarcely a choice that would be made by anyone fully acquainted with the disease. Degenerative disease is one type of age-dependent disorder which is the concern of geriatrics; malignancy is another.

Since the onset of degenerative disease is insidious, because its causes as yet may be largely unknown, physicians are limited today to a few corrective measures of palliation. They cannot rehabilitate the disordered physiology much less can they stop its progression. This means that diagnosis is at best uncertain and difficult, treatment largely empirical, and limited by individual experience to an undue degree. If physicians are to gain better insight into these disorders and perhaps as well into the phenomena of aging, they must have at their command a method whereby they can scrutinize minutely the performance of an organ system, or perhaps under certain circumstances, the cellular components of the system. Until the last few years there were no means by which this could be done except indirectly and then by great effort at high cost. It is desirable that there be a method whereby literally one can peer into cells and observe the happenings therein. Fortunately, radioactive isotopes permit just that to be done. By the emission of gamma activity one can externally follow movements through the body and by properly utilizing any form of radioactivity one can follow the sequence of synthesis and degradation that occurs in the normal utilization of foodstuffs, to building of tissue and its ultimate replacement.

When one studies disease states, one finds that there are two types of events which can clearly be separated from normal events. One is the synthesis of a compound not normally found within a cell, and the second, the converse of this, the failure to synthesize a compound normally a cell constituent. In this type of study, the capacity to label chemical compounds permits study of the kinds of chemical transformation that occur. With radioactive elements it is possible to introduce only a very minute amount of the material to be studied. Thereby no new factors of load are introduced which may of themselves alter the sequence of events. By choosing radioactive elements of different activities, that is, energy emissions of different half life, of different sequence of transformations, and of different particle emissions, one can bring to bear upon a single series of events a multiple type of examination.

The variegated responses to the question asked may then be most informative concerning the nature of the happenings, particularly in regard to changes that may have occurred as a result of what are commonly termed disease processes. This approach now can be carried out in a wide variety of manners depending upon the selection and utilization of the isotope. The development of reactors and accelerators which can be used to manufacture radioisotopes in large quantity and even more important the development of detectors capable of revealing quantities of radioactive isotopes so small that the radiation is not of significance to the whole organism, now make studies of this kind practical. They are limited only by the capacity to synthesize, isolate, or identify the chemical substances or the sequence of processes concerned.

In biochemistry the widespread and rapidly growing use of radioactive isotopic labeling attests best of all to the usefulness of the procedure. If no alteration of the compound is a

requisite, most organic compounds must be labeled either with radioactive carbon, or radioactive hydrogen, more commonly called tritium. While these labels are completely satisfactory within their own sphere of usefulness, neither has a gamma emission. Therefore, removal from the body, and in some instances, concentration may be required for analysis or detection. In other circumstances, however, it is possible to insert into the molecule a suitable gamma-emitting isotope such as iodine and thereby enable detection of the isotope by counters external to the body and observation of the isotope's movement within the body and its localization if such occurs.

A new procedure which is being developed by Cotzias at Brookhaven is the study of kinetic displacement rather than static displacement of one metallic element by itself or another. Cotzias' work has dealt largely with manganese (4, 5, 18, 19). Since most of the metallic elements have among their radioactive isotopes relatively weak gamma emitters of short half life, this approach has promise because distribution can be observed external to the body and these radioactive isotopes do not entail any significant radiation exposure. It is my belief on the basis of data presently being obtained that we must radically revise our usual concepts of the relations of metal ions to their physiologic environment and the roles they play. For instance, Dahl (8, 9, 10, 11) in an extensive study on the role of sodium in hypertension has shown that in some hypertensive patients on a low sodium diet and after a significant depletion of the sodium content of the body there is an increase in total active metabolic sodium pool. The reservoirs of this potentially metabolically active sodium are as yet unknown but are not unsought. In Parkinson's syndrome Cotzias and Borg at Brookhaven are using techniques incorporating radioactive tracers to study the metabolism of manganese since some altered distribution in manganese or some fault in manganese physiology of the central nervous system may be involved in this disease (4).

The role that trace metals may play in the metabolism of man is yet largely unknown. By means of radioactive isotopes, methods of study of metal behavior and occurrence not heretofore available can become almost routine. The further development and use of activation analysis will enable the investigator to analyze tissues for a galaxy of elements—the analysis being carried out without alteration or manipulation of the specimen and being effected simultaneously for all components using radiologic analysis to sort out the various components.

The study of the kinetics of distribution of an element permits examination, both analytically and mathematically, of body compartments which have physiologic uniformity as well as those which have anatomic uniformity (17, 21, 22, 25, 30). By choice of a suitable isotope, such as radioactive bromine 82, within a few minutes observations can easily be made on the size of the extracellular fluid compartment and by comparison with the distribution of tritiated water, quickly calculate the volume of intracellular fluids. Similar types of study with manganese indicate it moves into at least four compartments, each at a different but characteristic rate. These compartments have not yet been completely and satisfactorily described. Other elements permit examination at least in part of different combinations of the same compartments as well as other compartments.

These observational capabilities give promise of much new knowledge on the exact disturbances present in degenerative disease. With the use of radiation itself to produce degenerative disease analogs the possibilities are greatly enhanced (1, 2, 27). With such knowledge at hand, it is to be hoped that measures can be contrived which will control or alleviate these disorders. While the promise is great, as of this date performance is slight and much work remains to be done before the promise can slowly be fulfilled.

In the field of neoplasia, looking only at the areas using radioactive isotopes, I need only mention the application of cobalt 60 teletherapy, intracavitary therapy with colloidal gold and colloidal phosphorous, and infiltrative tumor mass therapy with these same colloidal compounds as well as cobalt 60 needles. In addition, I have been concerned in a basic study to explore the usefulness of the reactor as a medical instrument in experimental neutron capture therapy of glioblastoma multiforme (12, 13, 14, 15, 16, 24). In general, palliation and alleviation of malignancy can now be carried out more effectively than ever but cure as yet is not increasing as a result of newer procedures. Again, further researches will, I am sure, bring to hand more effective procedures than exist at present.

The phenomenon of aging itself in certain phases can be studied now most expeditiously through the development of a procedure to synthesize tritiated thymidine. This was originated by Hughes of Brookhaven's Medical Department. Tritiated thymidine, together with tritiated cytidine, permits one to label newly formed nucleic acids and thereby establish clearly which cells are dividing and which are no longer capable of reproducing (20, 23, 26, 29). The multiple applications of this very recent development are apparent on a moment's thought in relation to age. The same procedure may well also have direct application to degenerative disease problems as well as wound repair, fracture healing, and maintenance of physical integrity of the central nervous system. Many of these areas are under preliminary study even now.

Finally, I should like at this point to alter this discussion to a very brief consideration of degenerative conditions of the skeletal system that may be, at least in part, caused by environmental changes. In this day and age, with the rapid development of atomic energy and its utilization in industrial endeavors as well as military efforts, it becomes necessary for each physician to acquaint himself with some of the physiologic effects of radiation and of tissue-deposited radioactive isotopes (1, 3, 6, 7,). It is a fact that we all are exposed to a small amount of radiation coming from fallout from weapon testing by ourselves, our friends, and those not so friendly to us. Therefore, physicians must be on the alert for disease disorders which may be caused, exacerbated, or made manifest by small but significant depositions of radioactivity in organs such as the skeletal system.

Today radioactive strontium is receiving most publicity. Radioactive strontium taken internally is mainly excreted, but that fraction not excreted is in large part deposited in the skeletal system. Before the ills of the aged in the future are blamed on such accumulations in man, there must be reasonable proof of the disease sequence inferred. If the behavior of radium deposited in bones is any criterion for the behavior of radioactive strontium, then one may expect to see relatively localized disturbances in bone with crippling disorders occurring only after many years. To my knowledge no instances of leukemia have followed exposure to radium even when it was given intravenously as a therapeutic measure such as was done during the early 1920s. Sarcoma of the bone has been seen but the surprising fact is how well so many individuals have tolerated 30 years of radium exposure in their bones. These studies have revealed characteristic roentgenologic changes in bone which permit a quite accurate provisional diagnosis to be made. Let us take care then that in the future we are circumspect in attributing disease states only to agents for which there is reasonable proof as has been the habit and custom of physicians at all times and remains so today. This does not mean we have no concern about radiologic exposure—we should have deep concern, but there is no cause today for alarm. Careful, protracted, specific observations and introduction of all safeguards for patients and healthy persons are prerequisites and must not be minimized in any degree.

Because of delayed effects of radiation, it must be a special charge upon those who care for the older pesrons in our population to scrutinize each patient carefully, to make complete objective recordings of findings, that our knowledge may be increased and our confusion lessened. Those who are charged with responsibility for medical care of older persons must be constantly on the alert for any changes which suggest that some new factor has been added to disease causation of the older age groups. Such leads must be promptly investigated in order that their significance may be established. It is mandatory that physicians become conversant with expected signs and symptoms of radiologic exposure that in cases wherein radioactive elements are suspected as being a causative factor in the illness, the proper steps can be taken to verify the diagnosis and to follow this with appropriate therapy.

Since atomic medicine is still in its early infancy no one can bring to hand developed solutions for such problems of the older segment of population as can most effectively be attacked by these new procedures. For the first time, however, the possibility exists that the disorders of degenerative disease can be profitably and expeditiously scanned. With better understanding, better management of these perplexing disorders may confidently be expected. Additional palliation of malignancy is already at hand with more effective procedures undoubtedly over the horizon. The phenomena of age itself can be explored more effectively than ever before. Only gradually will these advances, as

they can be developed and tested, become incorporated into the general practice of medicine. There is no millennium at hand but the resources of the specialist in geriatrics bid fair to receive extensive reinforcements from the inevitable progress of nuclear medicine.

## REFERENCES


1. Bond, V. P., and Cronkite, E. P.: Effects of Radiation on Mammals (A Review). *Ann. Rev. Physiol., 19:* 299-328, 1957.
2. Conard, R. A.: Some Effects of Ionizing Radiation on the Physiology of the Gastro-intestinal Tract. A Review. *Radiation Res., 5:* 167-188, 1956.
3. Conard, R. A., Huggins, C. E., Cannon, B., Richards, J. B., and Lowery, A.: *Medical Survey of Marshallese Two Years After Exposure to Fallout Radiation.* BNL Report 412 (T-80) March, 1956.
4. Cotzias, G. C.: Manganese in Health and Disease, *Physiol. Rev.* (in press).
5. Cotzias, G. C., and Maynard, L. S.: Study of Certain Phases of Cell Dynamic States with Short-lived Isotopes Exemplified by $Mn^{56}$ Partition Studies in Organs and Intracellular Organelles. *Intl. Conf. on Peaceful Uses of Atomic Energy,* Geneva, July, 1955.
6. Cronkite, E. P., and Bond, V. P.: Effects of Radiation on Mammals, (A Review). *Ann. Rev. Physiol., 18:* 483-526, 1956.
7. Cronkite, E. P., Dunham, C. L., Griffin, D., McPherson, S. D., and Woodward, K. T.: *Twelvemonth Postexposure Survey on Marshallese Exposed to Fallout Radiation.* BNL Report 384 (T-71) August, 1956.
8. Dahl, L. K., with tech. assist. of Reilly, L.: Evidence for an Increased Intake of Sodium in Hypertension Based on Urinary Excretion of Sodium. *Proc. Soc. Exper. Biol. & Med., 94:* 23-26, 1957.
9. Dahl, L. K., Stall, B. G., and Cotzias, G. C.: Metabolic Effects of Marked Sodium Restriction in Hypertensive Patients. Skin Electrolyte Losses. *J. Clin. Invest., 34:* 462-470, 1955.
10. Dahl, L. K., and Love, R. A.: Evidence for Relationship Between Sodium (Chloride) Intake and Human Essential Hypertension. *Arch. Int. Med., 94:* 525-531, 1954.
11. Dahl, L. K., Stall, B. G., and Cotzias, G. C.: Metabolic Effects of Marked Sodium Restriction in Hypertensive Patients: Changes in Total Exchangeable Sodium and Potassium. *J. Clin. Invest., 33:* 1397-1406, 1954.
12. Farr, L. E.: The Experimental Application of Neutron Capture Therapy to Glioblastoma Multiforme. *Acta contra Cancrum, 11:* 500-504, 1955.
13. Farr, L. E.: The Medical Uses of Nuclear Reactors. *Bruxelles-Medical, 37:* 843-858, 1957.
14. Farr, L. E., Robertson, J. S., and Stickley, E.: Use of the Nuclear Reactor for Neutron Capture Therapy of Cancer. *Intl. Conf. on Peaceful Uses of Atomic Energy,* Geneva, July, 1955.
15. Farr, L. E., Sweet, W. H., Locksley, H. B., and Robertson, J. S.: Neutron Capture Therapy of Gliomas Using Boron,[10] *Tr. Am. Neurol. A.:* 110-113, 1954.
16. Godwin, J. T., Farr, L. E., Sweet, W. H., and Robertson, J. S.: Pathological Study of Eight Patient with Glioblastoma Multiforme Treated by Neutron Capture Therapy Using Boron[10]. *Cancer, 8:* 601-615, 1955.
17. James, J. A., and Robertson, J. S.: Estimate of Exchangeable Water and Potassium by Radioisotope Dilution in Children. *J. Dis. Child., 93:* 217-222, 1957.
18. Maynard, L. S., and Cotzias, G. C.: The Partition of Manganese Among Organs and Intracellular Organelles of the Rat., *J. Biol. Chem., 214:* 489-495, 1955.
19. Maynard, L. S., and Fink, S.: The Influence of Chelation on Radiomanganese Excretion in Man and Mouse, *J. Clin. Invest., 35:* 831-836, 1956.
20. Painter, R. B., Forro, F., Jr., and Hughes, W. L.: Distribution of Tritium-labeled Thymidine in *Escherichia Coli* During Cell Multiplication: *Nature, 181:* 328-329, 1958.
21. Pittinger, C. B., Conn, H. L., Jr., Featherstone, R. M., Stickley, E., Levy. L., and Cullen, S. C.: Observations on the Kinetics of Transfer of Xenon and Chloroform Between Blood and Brain in the Dog. *Anesthesiology 17:* 523-530, 1956.
22. Robertson, J. S.: Theory and Use of Tracers in Determining Transfer Rates in Biological Systems. *Physiol. Rev., 37:* 133-154, 1957.
23. Robertson, J. S., and Hughes, W. L.: Intranuclear Irradiation with Tritium-labeled Thymidine. *Proc. Nat. Biophys. Conf.* (in press).
24. Robertson, J. S., Stickley, E., Bond, V. P., and Farr, L. E.: The Proposed Brookhaven Medical Research Reactor, *Nucleonics, 13:* 64-68, 1955.
25. Robertson, J. S., Tosteson, D. C., and Gamble, J. L., Jr.: The Determination of Exchange Rates in Three-compartment Steady Closed Systems Through the Use of Tracers, *J. Lab. & Clin. Med., 49:* 497-503, 1957.
26. Sinex, F. M.: Aging and the Lability of Irreplaceable Molecules, *J. Gerontol., 12:* 190-198, 1957.
27. Shellabarger, C. J., Cronkite, E. P., Bond, V. P., and Lippincott, S. W.: The Occurrence of Mammary Tumors in the Rat Following Sub-lethal Whole Body Irradiation, *Radiol. Res., 6:* 501-512, 1957.
28. Strobino, L. J., and Farr, L. E.: The Relation to Age and Function of Regional Variations in Nitrogen and Ash Content of Bovine Bones, *J. Biol. Chem., 178:* 599-609, 1949.
29. Taylor, J. H., Woods, P. S., Hughes, W. L.: The Organization and Duplication of Chromosomes as Revealed by Autoradiographic Studies in Tritium-labeled Thymidine, *Proc. Nat. Acad. Sci., 43:* 122-128, 1957.
30. Van Slyke, D. D.: *Hydroxylysine.* Jubilee Volume in honor of Prof. A. Stoll. Birkhäuser Verlag, Basel and Stuttgart, 1957.

# PSYCHOLOGICAL AND SOCIAL SCIENCES SYMPOSIUM

## THE ASSESSMENT OF MENTAL AND SOCIAL HEALTH IN RELATION TO AGE

A. T. WELFORD, M.A.
*(The Psychological Laboratory, Cambridge University, England)*

The problem of assessing health, whether medical, mental, or social, is initially a problem of definition. Most of us know what we mean when we say someone or some society is healthy or unhealthy, but, when we try to put our meaning into precise terms, we find we are strangely unable to do so.

A number of attempts have been made to devise objective methods of stating degrees of health. All depend fundamentally upon assigning marks for ratings on a number of qualities or activities and then adding the marks together to act as an "index of health." This method does, in a sense, accord well with what we do in subjective judgment: we take several factors into consideration and try to make our over-all judgment in terms of them all simultaneously. Yet nobody is really satisfied with this method. Apart from the difficulty of knowing whether the qualities we are rating are the most significant we could choose, the marks are inevitably arbitrary: we do not know in what sense *2* is twice *1*; and, this being so, we cannot with confidence add them to make a composite score. It is true that refined statistical techniques can give a more rational scoring system in some cases, as when scores are weighted following a factor analysis of preliminary results. Yet this is only a partial solution: it is really measuring only internal consistency and does little to improve the validity of the ratings.

Anyone who criticizes in this way ought to be prepared to undertake the very much more difficult task of making constructive suggestions for better methods. I shall try to make such suggestions in terms which are as basic as possible, not only to the mental and social health of old people, but to health in general.

Ill health seems commonly to be used to imply a deviation from normal, either the normal of the individual or that of the society in which he lives, in an undesirable direction and in ways which are not under the subject's immediate voluntary control. What constitutes ill health in old age must therefore depend on whether or not we take normal age changes into account. If we do not, then all old people are to some extent unhealthy in that their capacities are impaired relative to those of the adult population as a whole. If we do take normal changes into account, we have to apply different criteria of health in different periods of life.

Whichever we do, there seem to be two fundamental ways of approaching the problem: first, by the assessment of human capacity and, second, by a consideration of the environmental, including social, demands which an individual is able or unable to meet. The difference between these two approaches is largely one of viewpoint, since in our present state of knowledge we can very seldom measure the first except in terms of the second.

### THE ASSESSMENT OF CAPACITY

The method of assessing capacity by multi-item "tests" has the advantages of possessing simplicity and of often being suitable for use by relatively unskilled investigators. These tests do not normally measure capacity, but they rank individuals in order of merit. This is not an important limitation. What is more serious is that the tests usually lump together the effects of many different capacities and that the process of finding out just what is being assessed is a laborious process, if indeed it is possible to do so at all. Also the scores commonly fail to bring out differences in method of performance which may be quite as significant as differences of over-all achievement. Thus a single score on a speeded test does not distinguish between those who are slow but accurate and those who are quicker but make more errors.

One seemingly obvious cure, using tests without a time limit, is inadmissible. Speed and accuracy are both indicators of change with age; and the first often provides an earlier and more sensitive indicator than the second. This is not to say that higher levels of thought may not be achieved and more complex problems solved if more time is taken. Nor does it deny that the slowness of older people may not sometimes go with enhanced achievement of these kinds. The work of Hick (1), however, has made it clear that, in principle, speed and accuracy are compensatory so that both must be considered in any truly comprehensive assessment of performance.

The basic factors, or "functional entities," which go to make up human capacity cannot be teased out of the complex of human performance by examination of performance alone; some principles outside the system must be brought in. Thus factor analysis is not an allowable procedure unless we have external criteria by which to fix every axis (except perhaps one). The most desirable external criterion is physiological knowledge. Our understanding of cerebral physiology, however, is so scanty that we tend to fall back on analogue "models," mathematical, mechanical, or electronic, some of which try to offer rather detailed explanations of behavior in pseudophysiological terms. In our present state of knowledge it is perhaps wiser to attempt the more conservative tasks of locating changes of behavior rather broadly in the chain of mechanisms between the sense organs and the effectors and of trying to infer principles of their operation. Thus, for example, different patterns of slowing with age at different tasks indicate that more than one mechanism is involved. These different patterns can teach us something of the way in which the mechanisms function (2).

We have found two techniques valuable in making studies of this kind. The first is to use fairly complex tasks, comparable to those of semiskilled industrial work, and to analyze these into component parts, scoring each part separately for time and accuracy. Commonly, only some of these components change with age, or they change at different rates. By this means, the significant differences between older and younger can be located more precisely and with less effort than could be done from a series of experiments which took only measures of over-all achievement at complex tasks or which attempted to study isolated functions. The second technique is that of presenting subjects with the same task in several slightly different forms, varying some features systematically to produce different degrees of difficulty.

The results of these experiments have usually shown nonlinear trends with age. The most common result has been that performance changes very little up to a certain age, after which there is a clearly marked fall. The age at which the fall begins tends to become earlier with more difficult tasks.

We may suspect in a case like this that *capacity* is falling continuously with age but that some other factor is limiting performance to a level well within that of the younger subjects; and that only when capacity has fallen substantially does it become limiting itself. Once performance has started to fall, it goes on doing so until it breaks down completely. What sets the upper and the lower limits of achievement in this way is a matter for further study; and it probably varies from one performance to another. We may, however, be fairly sure that in a large number of cases the upper limit is determined by some factor having nothing to do with the subject's capacity but one that is dependent upon some external demand. Thus, for instance, the speeds at which we walk, drive, eat, drink, or even carry out factory work are more commonly limited by social conventions or by the machinery we are using than by our capacity to do these acts fast. The most interesting zone, from our point of view, lies between the point at which performance ceases to be independent of age and that at which it ceases to be effective altogether.

The pattern of a "transitional zone" between rather definite limits may become partly obscured, especially if a group of subjects is tested, because any variation between individuals in their points of inflection will "round off the corners of the curve" and make the change with age look like a continuous, although still nonlinear, function. Further obscuring of the pattern may arise if the subjects compensate to some extent for failing capacities by changing their methods of work. In this case the fall of achievement may be postponed, but at the same time there will be a qualitative change in the manner in which the task is done.

When this pattern of results is found, it means that level of achievement cannot be

conceived as dependent in a simple way upon the sum of the capacities possessed by an individual; wide variations in one or another capacity may occur with no corresponding change of achievement. It further means that we must be careful when correlating scores for different performances. We should, indeed, deal in detail with the functional relationships rather than with correlations. This approach and treatment, while it opens up a rigorous method of relating performance to capacity, makes the immediate task of assessing capacity more laborious and requiring of more care. It would, however, seem to give promise of an eventual simplification, in that it enables us to identify basic capacities more precisely, and indicates that there are zones of difficulty in a task in which the effects of these basic capacities will show to maximum effect and in which it is therefore easiest to measure them.

To summarize so far, it would seem that we know enough to be confident that the task of sorting out the basic functional entities from the flux of human behavior is not easy, but that it is nevertheless a realistic aim. We may look forward in the future, therefore, to assessments of "mental," occupational and social health in more fundamental terms than have been available hitherto. Admittedly, if we realized our aim, we should still need to know how the functions we had discovered as basic were related to actual observable behavior. This information we should, however, gather incidentally on the way.

## ASSESSMENT OF ABILITY TO MEET DEMANDS

If our interest in assessing ability to meet the demands of life is the practical one of deciding where there is need for social action, welfare services or modification of work conditions, the simplest and most frequently used method would seem to be to classify individuals into those whose performance is, and is not, being impaired for want of the action or service or modification concerned. Thus, for example, we know that rigid pacing of industrial work is a source of severe difficulty for older employees and that its removal could render many jobs more suitable than they are at present for men and women in the late fifties and beyond. In assessing the probable effects of speed stress, we must, however, recognize that its removal would, in many cases, merely reveal some other source of limitation. Similarly, action to remove other limitations might reveal additional cases of undue speed stress.

If the coincidence of different limitations in the same individual was strictly or approximately random, the assessment of their joint probabilities would be a simple matter. Almost certainly, however, they are not random; and at present we have no means of knowing reliably what their joint probabilities are. Some of the necessary data may well exist in the results of surveys already made, and analyzing such data for this purpose would seem to be a worthwhile piece of research.

This kind of approach would not, however, enable us to assess levels of health in individuals. For this we must face the problem of putting together measures or assessments of ability to cope with a variety of situations which can jointly give an indication of how far a person achieves, or falls below, any standard we may lay down as a definition of "healthy." The pattern of relationships between capacity and performance already outlined would seem to provide a new approach to this problem which, although it needs to be worked out in more detail before it could be used, would seem more rigorous than methods of assessment used hitherto and appears to be, in principle, simple to apply.

We have suggested that performance may be divided into three zones: 1) Achievement is limited by some factor external to the subject, such as a social norm or a limitation in the equipment he uses to do an industrial job. 2) The subject's own capacities limit his achievement. 3) Capacity is so low that the task cannot be done at all.

The first and third of these are, of course, not absolute, although in many cases they are nearly so. What we can do, however, is to regard them as limits and to try to score the second on a scale running continuously from the one limit to the other. We might perhaps do this in terms of the *probability of an adequate performance*, or of the *reciprocal of the time* taken, or some combination of both. (In spite of Hick's important work (1), more research is needed on the methods of relating speed and accuracy.) If we score the upper limit as 1 and the lower as 0, and take the upper limit time as unity, *both* measures would run from 0 to 1 and both could be averaged between different tasks. Inaccuracies and difficulties of measurement might mean that the

upper limit would be less than 1 or might exceed 1 in particular individuals compared with a group norm, but these would not in practice matter seriously.

Ideally such a method should be applied to performance measured in "real" units. For practical purposes, however, subjective assessments would probably not be in serious error provided that a substantial number of performances were rated and that, of these, a fair proportion could be rated 0 or 1. Some inaccuracy would, of course, arise, but this would probably be small compared with the many other inaccuracies almost always present in psychological and social measurements.

## RELATIVE WEIGHTING OF DIFFERENT CAPACITIES

One omission has probably been obvious in both the methods of assessing health discussed so far: we may combine several capacities or the performances on several tasks to make our over-all rating, but surely we should not give each of them equal weight. Some are clearly more important than others and should count for more in the over-all index. In the last analysis this weighting must, from a psychological point of view, be arbitrary, since it must depend on social or ethical values outside the capacities being studied. What is required is no less than that we should express these values in a form in which they can weight our ratings.

There are two fundamental ways in which this could be done. First, the values might form a logical structure in which they operated in an all-or-none manner and so enabled us to regard one capacity as all-important and all other capacities as negligible. Second, we might be able to set quantities to the values and use them as weights for the scores of our various performances. Subjectively, most people probably do both of these to some extent but incline more toward the latter.

Short of having a scheme laid down for him from outside, is there anything a psychologist can do in this matter? The relationship between social values and behavior is not well understood, but one guess which might be worth exploring is that values will be reflected in the amounts of time devoted to different activities. This will obviously not be wholly true, but, if it is true at all, it can form the basis of a better index of "health" than one giving equal weight to all activities. To arrive at such an index, we should take measurements or make assessments of the actual performances (or of the capacities used in them) with which people fill their days and weight the scores according to the proportion of time the performances occupy, scoring 0 for any time spent "doing nothing."

When dealing with individual older persons, we might take as our "norms" of daily timetables the average either of their contemporaries or of younger people, or (if the necessary longitudinal study could be made) their own timetables when younger. Perhaps the fairest assessment, however, would be the simplest, namely, to take each man's present timetable and score the effectiveness he shows in living through it. Only in this way can due weight be given to the fact that probably the most successful adjustment to old age is to modify the pattern of one's activities so as to concentrate on those through which one can still make one's best contribution.

## REFERENCES

1. Hick, W. E. On the rate of gain of information. *Quart. J. exp. Psychol.*, 1952, **4**, 11-26.
2. Welford, A. T. *Ageing and human skill.* London: Oxford Univer. Pr. for the Nuffield Foundation, 1958.

# PRESSURES OF LEISURE ON THE OLDER INDIVIDUAL

MAX KAPLAN, Ph.D.
*(Consultant, Arts Center, Boston University)*

A reasonable way to begin an analytic paper is to define one's terms. Yet the difficulty of defining the term "leisure" is an immediate clue to the lack of systematic treatment which leisure has received at the hands of social scientists. I do not dare stretch these preliminary comments to cover the vital matter of conceptualization, for such a treatment could not stop short of a comprehensive re-examination of the way in which anthropologists, sociologists, and culture historians have examined our major economic, political, religious, marital, and educational institutions. In the interest of time (after all, my topic is time), permit me to make several arbitrary conclusions at the very beginning.

## SYSTEMATIC PATTERNS IN STUDY OF LEISURE

In my view, no definition of leisure can be found which is operationally useful to research or informed observation. We need, rather, an "ideal construct," as Max Weber developed this tool (11; also 1, 9). In my own construct, the elements of leisure are: (1) antithesis of work as economic function, (2) pleasant expectation and recollection, (3) minimum of involuntary social-role obligations, (4) a psychological perception of freedom, (5) a continuity of values from the culture, (6) inclusion of the entire range from inconsequential and insignificant activity to that which is most serious and important.

This conception treats of leisure as something distinct from recreation or play, although related to these concepts. Its emphasis is on leisure as a type of social relationship in culture, with meanings which arise out of historical and contemporary developments. It views play, recreation, leisure (these are not the same in meaning) as situations within systems of norms whose functions can be many, subtle, indirect, unexpected, and can, for the most part, escape our current techniques of measurement. In the late thirties, my job with the United States Public Forum in Milwaukee required me to find out the motivations and factors which brought people to the many discussions we had arranged on political and social issues. We obtained questionnaires from the members of our audiences to show us their educational backgrounds, their ages, their occupations, and so on. But among the surprising things we noted was that in poorer sections of the city the attendance went *up* as the thermometer went *down*. Some interviews gave us the answer: many persons came to keep warm and save on heating in the home. So our approach to leisure, in these early stages of our scientific knowledge, must be prepared for serendipitous findings.

The scientific issues concerning leisure as a cultural and social relationship are three:

1. What does this activity mean to people? How do they see it? What functions does it provide in their lives?

2. How is this activity related to other activities, interests, attitudes, and parts of society? How does it "fit into"; how is it "integrated with"; how is it independent from, or dependent upon, other processes and activities in the same community or culture?

3. Who are the people involved in this activity? Why not other people? How did these people become involved? How open were their choices? How does this activity express their image of themselves and of others?

These questions assume, methodologically, that we must abstract from the total picture those elements or variables which have an impact upon a specific situation, and also that a typology of leisure activities is demanded in order to structure the situation for more precise observation and interpretation.

Finally, in terms of criteria which our society holds up from the accumulated experience and wisdom of its leaders, we must develop a range of less desirable to more desirable effects of leisure upon person, family, group, or community.

It is only within some systematic treatment of the over-all picture that we can then study the issue of leisure as it pertains to the older individual, especially some of its hardships suggested by the term "pressures" in our topic title.

## FACTS BEHIND OUR NEW LEISURE

The simple facts of the "new leisure" need not long detain us. We know that perhaps 15–40 per cent of our total consumption expendi-

ture is for recreation and leisure activity and equipment, the figures ranging widely in accord with definitions. A United Press summary speaks of 35 billion dollars; *Business Week* uses the figure 281 billion! During 1950, almost 600 million dollars went into salaries of persons whose jobs were to serve the free time of others. We know that today about 40 million labor contracts call for at least two weeks' vacation with pay; that in 1850, the seven and a half million workers on farms and in cities of the United States worked an average of about 70 hours per week. A century later, our labor force of 69 millions averaged a 40-hour week (2, ch. 11). American labor has taken its recent gains in the proportion of about one-third more time to two-thirds increased pay. And the same social, economic, and technological factors which have released us from work have provided us with other instruments for the utilization of more time: the gadgets, the mass media of communication, better health and food, the means of communication and transportation, better homes, and the service-minded community.

Some general preliminary observations must be made before we can come to grips with our topic:

1. The material gains of the past century, in terms of goods and income, have affected all of us, but to the proprietor and the managerial groups have accrued the advantage of new power and benefits. The recent and projected gains in *time*, however, are most marked among the unionized skilled and unskilled workers.

2. This new element, mass leisure, whose potential in time and content rests most dramatically with the working groups, requires a fundamental shift in our thinking about social classes, especially in regard to their perceptions of norms of behavior and sanctioned activities as well as their styles of personal and family life. The upper classes of Europe did not have to work, did not know how to work, and were experts at play or at exploiting the symbols of play. The American man of wealth, normally a product of the business world, knows nothing except work. Play, retirement, unobligated time—these are strange to him. Consequently retirement is often feared, delayed, or disguised, and is seldom approached with wisdom, grace, or pleasant anticipation. Thus the beneficiaries of our leisure have no upper-class models (Veblenese or otherwise), a loss from which I am not sure they will suffer.

Thus persons in our country who are in their sixties and seventies are pioneers in the new leisure, setting patterns for successive generations of older people. Their values arise from two major sources: first, a philosophical-religious ideology brought from Europe, in which work is the source of meaningful interrelationships and personal dignity; second, our past needs as a pioneering, rural, and pragmatic people, in process of building a technological, megalopolitan giant.

## WORK AND LEISURE

The first "pressure," or issue, in leisure emerges as a feeling that usefulness is found only in work. Work has been, unto the last moments of life, the core of our being and belonging.

Social sciences have made a signal contribution by providing an enlarged understanding of work. The view shifts from work in its intrinsic aspects (the worker in relation to his job) to work in its extrinsic aspects (the man whose work is one aspect of a many-sided web of human interactions). From this view, a chief issue in leisure is that the retired person may be finished with the intrinsic economic aspects of his productive life but that the extrinsic factors can be continued. If commitment or obligation be taken as one element of a normal work situation, can these elements not be found in nonwork spheres?

For instance, in trying to develop a construct of the perceptions of leisure, I find that the manner in which persons define leisure for themselves has nothing to do with the *content* of the activity. The tendency is to say, "I'm so busy with clubs [or church activity or civic projects], I have no time for leisure." Thus it is a mistake to deal with a simple dichotomy of work and nonwork. Rather, we must develop an approach to types of commitments and to distinctions between the form and the content of leisure.

In one of his writings, Havighurst indicates how the routine of the workday is replaced by the parallel structuring of the day in retirement:

> Now he may develop a new and more leisurely routine, getting the morning paper and reading it, tending the furnace or starting the fireplace, reading the mail, doing the marketing, working in the garden just before lunch, taking a nap after lunch, going to the library or the park or a clubroom for a couple of hours in the afternoon, reading the evening paper, eating supper, going to a meeting or a movie or listening to the radio, or going

slowly to bed. This routine is unexciting to a younger person, but to an older person, it may give all the satisfactions that the swifter tempo and more energetic activity of his earlier routine afforded [4, p. 310].

Note the phrase, "but to an older person." It is crucial to remember that *what* is meaningful to the older person is not necessarily what someone else decides. Our purpose, I feel, is the same here as in all education or service where judgments and a variety of standards exist: our objective is always to expose the learner, young or old, to a range of possibilities and to the challenge which exists after the present point of achievement. I cannot go along with Kronenberger that ideal leisure is free of meaning (6). Even the ideal of such freedom is a kind of existential value which is only one possibility, but not an ideal value for everyone at all times.

Professor L. Lowie, of Boston University, tells me that, in his work with older persons in Bridgeport, Connecticut, a golden age center was held from nine to five daily except Saturday and Sunday, thus providing a psychological parallel in time between work and retirement. Often, indeed, the content of these leisure hours is more meaningful than the previous work hours had been. Indeed, as we draw farther away from our work, we become less concerned with the relation of the content between the work and the postwork stages in our lifetime. It is interesting to note that a new demographic phenomenon has developed in our personal lives. Our first period of 20 years is pre-work; there follows an approximate period of 40 work years; and now, another 20 years of retirement. In this pattern of 20–40–20, the second 20 is qualitatively unlike the first 20. Childhood and adolescence are preparations, when values are absorbed and tools for work and living are sharpened. In the last 20, the third act in this new dramatic script, the summation of the previous two acts—a total of 60 years of role-playing—is achieved. Those serious and intense elements of play which Huizinga wrote about in his *Homo ludens* are most appropriate in this climactic grand act (5). But in both stages of life, the first as well as the last, we now see a clear parallel of new learning, creative unfolding, and, most important, a search for meanings in life.

This leads to another major observation for the consideration of this conference. All people, but especially older persons, are concerned that whatever they do have meaning. Their fear of retirement is largely that the rest of their lives is rendered meaningless. They want more than just to pass the hours. Centers for the aged might do well, therefore, to avoid the term "recreation" in their names and to establish a connotation that the centers cover a whole range of service and opportunity, that in these centers of leisure for creative living, "the human organism is involved in an educative process . . . where our senior citizens may become integrated with their community, alerted to new challenges in the later years." (8, p. 39).

## TYPES OF LEISURE

The concern of a leisure philosophy and program is, therefore, that it must be grounded on firm analysis of kinds of human activities which are ordinarily available to older persons, which can be created by them and with them; and, further, that the kinds of meanings and commitments can be found through or within the activity. In my own thinking, I deal with a classification of eight types of leisure. A cursory glance at a few of these suggests both the possibilities and the hardships for older people.

*Sociability* exists when people are together with no other thought than a liking for each other. Georg Simmel presented a classic formulation of sociability, including such elements as tact, random conversation, informality (12, pp. 40–57). The older person often wants someone to whom he can talk, someone who will listen. The danger is that, in the organized leisure program, simple conversation is overlooked in the American emphasis on movement and the outward appearance of "being busy." Reisman's comment on "active" and "passive" recreation is to the point:

> Much leisure which appears to be active may be merely muscular; its lactic acid content is high, but there may be little other content, or contentment. And conversely, such supposedly passive pursuits as movie-going can obviously be the most intense experience, the most participative [10, p. 206].

Pressure is sometimes placed on older persons to become "active." But the older individual has much to recount of the past and of his part in it, and this, for him, is meaningful activity. Even his complaints about his treatment by society, his economic plight, or the disrespect of his children—these must be heard, for, in the

hearing, a service is being performed. The classic situations for sociability are in relationships between family members and between friends. No program is necessary, no schedules, no elaborate training of professional people. Just people brought together with people—talkers with much to tell, listeners with genuine willingness to learn.

*Association* is a second type of leisure activity. Here people meet with a common, inclusive interest which is larger than their differences. The most important of interests which bring older people together is a collective concern with their destiny as the oldest generation.

Workers in the field report that this common bond makes friends of older persons whose religious and ethnic differences might have been barriers in their younger days. Associations can, of course, center in any interest, from a political decision group to the collecting of stamps. Here are obvious situations for activity which can be important and highly meaningful, in which status can be achieved, leadership exercised, and all the fantasy of interacting social roles be played out in rewarding patterns of harmony as well as productive conflict. The pressure or danger to guard against in associations formed by, or for, retired persons is fundamentally the pressure put on such persons by others to keep the central concerns of the group on a purely entertainment, insignificant, or noncontroversial level. Further, we must watch against the tendency in some leadership circles to overdirect the club or group or to overinsist on "active" participation by every member.

*Games and sports*, a third type of leisure activity, are characterized by rules, concepts of victory and defeat (in the case of games), and mastery over oneself or of nature (in the area of sports). Here will sometimes be found a tendency among professional workers to underestimate the learning ability of the older person. The serious content of games for the older group is often not the game itself but the instrument provided for sociability. The card game, for example, permits a combination of attention and inattention, of talk about cards and about anything else, of skill and luck, of solo and paired performance. Chess and checkers provide similar possibilities for pairs of players. Many centers report considerable enjoyment of spelling bees, guessing games, charades, all of which combine social mixing with possibilities for individual ingenuity or achievement. We must expect less concern among older people with the fruits of victory; they, more than their children, have a perspective on the place of play as a separate world of its own, not to be taken for reality.

The choice of games by age groupings is frequently based on nothing more than previous conceptions of what is expected of these groups. We are all familiar with studies of attitudes toward aging held by younger people which bear this out. Lorge and Tuckman (7), for instance, in a study of 533 students in junior and senior high schools, found that 93 per cent were able to mention a specific year when old age begins; these stipulated ages ranged from 18 to 92!

I am now completing a study, in which college students predict the sorts of leisure activity in which they will be engaging in the year 1976 and 2000, when they will be about 40 and 65 years old. Thus far I find that these years mean about the same to them and that, in both cases, they will sit in a corner, inactive, feeble, dulled. This finding suggests that we need to develop rapport between persons in gerontology and in education at all levels, so that healthier attitudes toward the capacities of the older person, in play as in other pursuits, are developed in our earliest years. What applies here to games is pertinent, of course, to all aspects of leisure.

In *art*, a fourth type of leisure, is to be found an exciting area for exploration with older persons. The possibilities for inducing creative activity are infinite in music, painting, writing, ceramics, design, and acting. Whether as creators, performers, watchers, listeners, or students, older people are finding themselves reborn; creative desires which had been put aside for decades can be developed. This Society could perform a service of the highest order were it to bring together for a national audience some of the fine pictures, plays, orchestras, choruses, operettas, handicrafts, and other artistic products created by older persons in many parts of the country.

Again, the aging person needs guidance designed to encourage, not to limit and stifle, him. Traditional standards are important to art, but, as a leisure activity for the older person, the approach is social as well as aesthetic: what art *does to me* as well as what *I do* with art. The pressure to be avoided here is that of the

pedantic teacher. The rewards to be sought through the arts are personal expression; insights into the use of materials and symbols; the response of others; the integration of personality; a concern with the concepts of beauty, form, balance, style, symbolic meanings. These are not experiences or adventures reserved for the young. A serious mistake that can be made is to underdevelop the rapport between gerontology and the arts. The pressures to be removed in this area are those emanating from unimaginative workers, overspecialized people who impose uncreative activity upon mature persons and underestimate their creative potentials. A recreational philosophy of art is one badly needed in institutions where leaders are trained. Martin Gumpert summarizes the philosophy we need:

> The majority of us in our so-called "prime of life" are so conditioned to the expedients of everyday living that we are often forced to suppress the creative wants and talents that may be buried within us. It takes a forceful fate—or the dimming lights of old age—to crack our acquired "surface" and release these impulses. I have seen, many times, the miraculous change that takes place in an old person who suddenly takes up some creative work—writing or painting or the skillful application of some new knowledge. Such a person then discovers, for the first time in his life, an existence of his own. Even if his efforts remain on the purely primitive level, he becomes aware of a new kind of inner freedom which helps him forget many of his aches and pains. . . .
>
> Many of the disabilities of old age are insignificant in creative work or even modify the personality in positive ways by instigating greater effort to compensate for loss [3, p. 73].

Another area of leisure includes activities involving *mobility* and *immobility*.[1] In the first we go *to* the world, as in travel. In the latter, the world comes to us, as through reading or watching the mass-communication media. In the second of these types, immobility, I am intrigued to find that there has been a fascinating reversal of age roles vis-à-vis television. Here are millions of young and middle-aged persons sitting in semidark living rooms, quite motionless, taking in images, geared to close schedules, developing stiff necks and poor eyes. Is this not a pattern we have stereotyped as one characteristic of old age? Meanwhile, according to some group leaders of golden age clubs, their members show almost no interest in TV except on special occasions. Perhaps the gerontologist should be concerned with the older population during the day and the younger person in the evening!

## CONCLUDING COMMENTS

My main point is already evident from what has been said: the major sources of difficulty for the older person, as he finds himself in situations of leisure activity, are that (1) he enters upon these experiences with an ideological worship of work and a suspicion of the idler; (2) he finds himself in a culture which has told him repeatedly that only the young can learn, grow, imagine, genuinely enjoy fresh experiences, and be creative. His problem in the first regard can hardly be resolved by conferences or writings. The solution will require a long time, and a whole new philosophy will have to evolve for the common man, one built around the abundance of time and things. If I may be so bold, I would like to suggest that a Judaic ethic which reconciles the spirit and the flesh will, under one guise or another, help provide a major shift in values; leisure, in a broad sense, provides a heaven within our daily grasp. As to the second difficulty, building a faith in man's creative possibilities in all ages of his life is an approachable goal.

It will be noted that this analysis has said nothing about the basic needs of man. In September I attended a conference of the Society for Creative Altruism. In spite of brilliant contributions by Eric Fromm, Pitirim Sorokin, Paul Tillich, Abe Maslow, and others, I remained unconvinced that evidence has been provided by axiology, ontology, biology, or psychology that man is inherently characterized by the need to "transcend himself," to "create," to "love," and so on. These are cultural values which I and others enjoy, values which have produced cultural traditions we seek to perpetuate. My thesis here is that basic attitudes toward the good life have historical and social roots. These change in time. The older person, like all of us, has limited choices within the cultural range available to him. He internalizes these cultural limitations and controls, so that often they appear, to him, to be inner feelings of guilt, choice, inherent deficiencies. If the new leisure is to become most significant (as the guardians of our culture have conceived concepts or standards of significance), then it will be largely because we permit members of the older generation to explore, seek, and create,

[1] This eight-point typology of leisure activities will be examined at some length in a volume now in preparation, *Leisure, a social inquiry*, to be issued by John Wiley & Sons.

and because we do not limit them by persistently seeking to overorganize, oversimplify, overdirect, or to underestimate the potential of all men, whatever their age.

## REFERENCES


1. Becker, H. *Through values to social interpretation.* Durham, N. C.: Duke Univer. Pr., 1950. Chapters 2 and 4 present useful discussions of the "ideal construct."
2. Dewhurst, F., & Associates. *America's needs and resources: a new survey.* New York: Twentieth Century Fund, 1955. For a condensed version, see *U. S. A. in new dimensions.* New York: Macmillan, 1957.
3. Gumpert, M. Old age's gain. *Harper's Magazine,* 1952, **204** (1220), 72-74.
4. Havighurst, R. J. Flexibility and the social roles of the retired. *Amer. J. Sociology,* 1954, **59,** 309-311.
5. Huizinga, J. *Homo ludens: a study of the play element in culture.* Boston: Beacon Pr., 1950.
6. Kronenberger, L. Our most personal possession, leisure. *House and Garden,* 1956, **109** (April), 96-97.
7. Lorge, I., Tuckman, J., & Abrams, A. J. Attitudes of junior and senior high school students toward aging. In New York Joint Legislative Committee on Problems of the Aging, *Growing with the years.* Legislative Document No. 32. Albany, New York, 1954.
8. New York Joint Legislative Committee on Problems of the Aging. *Brightening the senior years.* Legislative Document No. 81. Albany, New York, 1957.
9. Parsons, T. *The structure of social action.* Glencoe, Ill.: Free Pr., 1949. Pp. 601-610 provide a good discussion of the "ideal construct."
10. Riesman, D. *Individualism reconsidered.* Glencoe, Ill.: Free Pr., 1954.
11. Weber M. Die Objektivität sozialwissenschaftlicher Erkenntnis (essay). In *Gesammelte Aufsätze zur Wissenschaftslehre.* Tübingen: P. Siebeck, 1922.
12. Wolff, K. H. (trans.) *The sociology of Georg Simmel.* Glencoe, Ill.: Free Pr., 1950.

# THE IMPACT OF AGING ON THE ECONOMY

JOHN W. McCONNELL
*(Professor of Industrial and Labor Relations, Cornell University)*

The impact of aging on the economy depends on the characteristics of older people: how many of them there are, their continued employment or retirement, their health, marital status, income, and geographical location. The impact of aging on the economy also depends upon the nature of the economy: its organization, its goals, its traditions, its ability to provide jobs and to produce goods and services. Even if it were possible to catalogue the characteristics of older members of the population and describe the important elements of the economy, cause-and-effect relationships in a complex social system such as ours cannot be described precisely. There are too many independent variables, too many unknowns, too many situations which depend upon qualitative, rather than quantitative, factors to permit a definite analysis. Nevertheless, it is not unreasonable to ask, What is the impact of an aging population upon our economy? Even though an exact answer is impossible, certain trends can be observed.

The civilian noninstitutional population 65 years and over in continental United States now numbers about 14,420,000 persons. This age group increases at a rate of about 1,000 persons daily. In 1975 we shall have an older population of between 21 and 23 million persons. This age group now constitutes 8.7 per cent of the total civilian population. Whether this percentage will increase or remain relatively stable depends on the birth rate in the next 15 years. If the present high birth rate continues, the population 65 and over will then be only 9.4 per cent of the total population. If we return to the birth rate of the 1930's, older people will make up 10.7 per cent of the population in 1975. Older women outnumber older men by a ratio of at least 7 to 6. The ratio of older women to older men will get larger as time goes on.

Only 23 per cent of this older population is at work—37.3 per cent of the men, 10.3 per cent of the women. A majority of those over 65 consider themselves to be in poor health. About 50 per cent of the families and 75 per cent of the single persons have less income than a decent standard of living requires.

Our economy cannot be described in simple terms. It is a very complex bundle of institutions. Goods and services are produced, in the main, by large corporations. When needed, machines are financed by private savings. The exchange of goods between producer and consumer is made possible by the use of money and credit. Business organizations are run by paid executives, responsible to stockholders who judge the success of the enterprise by criteria such as profit per dollar of sales, earnings per share of stock, or prospects for future growth. Individuals work in public or private business establishments for wages or salaries. With their earnings they buy a living. Favorable rates of pay and working conditions are assured to wage-earners by the demand for labor, by union agreements, by law, and by the wage policies of employers.

What, then, is the impact of the aging population on this economy, which has just been described so briefly? Most obvious is the birth and rapid growth of new institutions to assure older persons a cash income. Family support of older members, and raising farm produce and live stock for a living are seldom possible for the older person today. A regular cash income is required. Government has put into operation vast systems of social insurance, retirement systems, veterans' pensions, and old-age assistance to meet this need.

To finance benefits and assistance to older persons, the federal and state governments collected in contributions and general taxes 11.5 billion dollars in 1955. The governments distributed in old-age benefits and assistance payments approximately 6.7 billion dollars to approximately 7.5 million persons. The reserves accumulated by the various public old-age insurance and retirement systems at the end of 1955 amounted to 41 billion dollars.

In addition to the public programs providing cash incomes to older persons, there are also

private pension programs. Approximately 14 million persons are covered by these plans, and approximately 1 million persons receive payments averaging between $50 and $150 per month, in addition to Social Security, depending on previous earnings and length of service. To finance these benefits, employers and employees contributed in 1955 about 4 billion dollars. Total reserves for private pension plans amounted to about 29 billion dollars at the end of 1956. Self-administered trust funds accounted for 16.6 billions and insured funds, for 12.3 billions. The funds increase at the rate of about 2.5 billion dollars per year.

Altogether, then, about 70 billion dollars have been set aside by government and industry as reserves against the future payment of pensions and retirement benefits. Annual contributions and taxes by employers and employees to finance old-age payments amounted to 15 billion dollars, or 3.6 per cent of the gross national product in 1955. Payments to older persons in 1955 from public and private sources, including veterans' benefits, amounted to 8 billion dollars, or 2.6 per cent of the national income or 3.4 per cent of consumer expenditures.

Between now and 1975 the contribution rates for Old Age and Survivors Insurance will double. The cost of private pensions now amounts to about 4 per cent of payroll, while an adequate supplementary private pension system might cost as much as 6 per cent of payroll. Between now and 1975 the gross national product is expected to increase by about 80 per cent. In other words, provision for a much larger older population, at higher standards than those which now apply, can be accomplished without setting aside any larger proportion of our gross national product than at present. National income has increased from $1.06 per man-hour of work in 1930 to an estimated $2.40 per man-hour in 1960. Even conservative estimates predict a doubling of productivity in the next 30 years. We will have ample resources to provide a decent living for all persons of 65 and over in the decades ahead. How these resources will actually be used is a matter for future economic and political decision.

Present plans of economic support for the aging will bring about some small redistribution of income. In the first place, benefits paid under OASI and most of the private pension payments are being financed directly or indirectly by younger age groups. Since 1950 beneficiaries under OASI have almost tripled. This vast increase resulted largely from retirements by newly covered employees, who paid contributions for a minimum of 18 months and began to collect benefits. Until the system matures, about 1975, those drawing benefits will be entitled to draw out considerably more than the contributions made by them or on their behalf. To that extent, younger workers must subsidize the retirement of older workers.

In private pension plans, also, benefit charges against retirement systems are much greater than any contributions made on behalf of those presently retired. One must assume that these charges are met in part by contributions in excess of those necessary to finance pensions for younger workers, and in part out of contributions being made for younger workers. Within the next two decades past service charges of the larger pension plans will have been met, and the contributions made on behalf of employees up to the time of their retirement will more closely approximate the benefit payments they will receive. Nevertheless, present pensions are being paid at the expense of benefits or wages to younger workers.

Furthermore, a pension payment is a claim upon production at the time the pension is paid. Even though the payment is made from money which was set aside for this employee in the past, the goods and services he buys are the result of present production. If we would avoid inflation, the contributions made to finance future pensions should, to the greatest extent possible, be used to develop increased productivity. Otherwise, liabilities to pensioners will exceed the capacity to produce additional goods and services and result in higher prices. The economic experience of the United States shows that shortages of productive capacity, when they occur, have been temporary. A rise in prices has never failed to occur, and, even though productive capacity catches up with demand, the resistance of prices to downward pressure prevents prices from falling back to previous levels.

To some extent, payments to older persons constitute a redistribution of wealth. Under OASI, part of the contributions by, and for, higher salaried employees pay for benefits received by lower wage workers. Employers' contributions to OASI and private pension schemes may, in some industries, be paid from income

which might have been paid to stockholders as dividends. The incidence of the cost of pensions depends largely on t competitive position of the company. Old Age Assistance is paid to those who have little or no income out of taxes levied upon those with income and property. But all these are very modest transfers, since the total payments to older persons amount to less than 3 per cent of the national income.

The accumulation of vast sums in public and private pension trust funds poses important problems of investment. The 40 billion dollars in public pension trust funds must be invested in government obligations. Controversies over this use of trust-fund reserves in past years have dealt with the possibility of double taxation on the one hand and, on the other, with incentives to government spending. In my opinion, the charge that the American public pays twice for OASI benefits is without any validity whatever, and merits no further discussion here.

The second charge, that such large reserves lead to increased government spending, has more foundation. For example, previous as well as current proposals that hospital expenses of OASI beneficiaries be paid for out of the OASI trust fund without increasing the rate of contributions have been made as expedients because the trust fund is so large. But recently, on the other hand, the contribution rate *was* increased to pay for disability benefits despite the existence of a reserve of over 20 billion dollars. However, since the budget-making functions of government are distinct from appropriations, it seems unlikely that the existence of a reserve increases the government's propensity to spend.

What is the proper use of social-insurance reserves? At present the government uses OASI trust funds to pay the current costs of government. It has been suggested many times over that these reserves, accumulated to pay benefits to persons at the time of retirement, should be used to finance self-liquidating facilities for older people, such as housing, cooperative workshops, medical centers, and the like. Such use of reserves would, of course, be a radical change, but not an unreasonable change, in American economic policy.

Recently the stability of the OASI trust fund has been questioned because in 1956 for the first time benefit payments dropped below contributions, with promise of a larger gap in 1957. Actuarial projections show that the present reserve, plus interest payments and future contributions, will pay all benefits and leave a reserve of about 200 billion dollars in the year 2000 on a low cost estimate. Given a high rate of unemployment, declining birth rate, widespread retirement at 65, and little or no increase in present wage rates, benefits could be paid until the year 2000 under the present financial arrangements, but the reserve would be exhausted. Intermediate cost estimates would leave the OASI Trust Fund with $100 million on that date (2). There is, consequently, no immediate threat to the financial soundness of the OASI system.

There are important effects of paying out more than is taken in. When OASI pays out more than it receives, the effect is inflationary. Bonds must be sold, usually to banks, to raise the needed cash. Furthermore, when OASI has a surplus, this money is loaned to the government at "bargain rates" (currently 2½ per cent, but, when OASI pays out more than contributions, the government must seek money from other sources at higher interest rates to pay benefits and to finance its other operations.

The reserves of the private pension plans have posed quite a different problem. The number of opportunities for private investment changes from year to year. Just a few years ago it was predicted that investment opportunity would be about 2 billions less than the funds available for investment. Such a surplus of investment capital could bring on deflation. Between 1950 and 1954 the economy produced a surplus of investment capital of from 2 billion to 6 billion dollars annually. At that time the prospect of a vast accumulation of pension reserves seeking investment led to very pessimistic projections of future economic trends. In 1955 and 1956, there was a shortage of investment capital amounting to from 5 billion to 7 billion dollars. The results are high interest rates and efforts by the Federal Reserve Board to curb inflationary tendencies by repeated increases in the rediscount rate.

Trustees of the self-administered pension trusts have adopted a more liberal investment policy than have insurance companies or the trust departments of banks. Common-stock investment on some such principle as dollar averaging or the balanced fund is common practice. About 23 per cent of the self-administered trust funds is invested in common stocks,

while nearly 50 per cent is in corporate bonds. Government obligations, once the favorite investment medium, now constitute a very small percentage of the average trust fund's portfolio. A few funds invest a very large percentage of their reserves in the securities of their own companies. The Sears Roebuck fund is the prime example of this form of investment, since it is the largest single stockholder of the company. Investments in their own companies account for about 10 per cent of the total of all trust fund investment. How sharp market declines will affect the character of pension trust investments is difficult to predict. It is easy to buy common stocks regularly in a rising market. It takes quite a bit of faith and steady purpose to invest these same amounts as the market falls.

The growth of all kinds of social-insurance programs covering the major economic risks has gradually changed the method of saving, though not the amount of saving. Since the Social Security Law was enacted, individual life insurance and other quasi-voluntary forms of self-protection have increased. From 1935 to 1957 life insurance in force in the United States companies rose steadily from 98.4 billion to 413 billion dollars. A large proportion of the increase came from company-sponsored group insurance. There is no evidence that the existence of public and private pension plans destroys the propensity to save. Personal saving has taken a more institutional form, and individuals have turned to automatic forms of saving through compulsory periodic payments and payroll deductions. *But they save.* Instead of decreasing, personal savings have increased, and many people do save who would not have done so in the absence of present forms of institutional and automatic savings. From a low of 10.5 billion dollars in 1948, personal saving has risen to 21 billions in 1956, the highest in any peace-time year.

The existence of vast public and private pension reserves and an older population for whom employment is a matter of indifference, economically speaking, is an important stabilizer of the economy. Dr. Townsend two decades ago argued that, if older persons were given pensions of $200 per month and required to withdraw from the labor market, we could spend ourselves out of the depression. The operation of OASI and private pension plans in a free labor market serves the same purpose on a more modest scale. As earnings fall, pensions look more attractive, and many workers are prompted to retire, leaving jobs for others who are out of work. Pension reserves are released into the market, and business is stimulated. While not so effective in countercyclical functions as is unemployment insurance, pension plans will be of considerable value in injecting stability in the economy.

Economic impact is more like a reciprocating action than a straight forward thrust. The payment of social security benefits made necessary by the increase in the number of persons over 65 has now been extended to farm operators and is causing sweeping economic changes in the farm economy. *Busines Week* called this development a "social and economic revolution that promises to bring great changes in age structure, farm management, retail trade, land tenure, and family relationship" (1). Some of the results already observed as OASI checks begin to flow into farm communities are:

Better income-tax returns are being received from farmers, which may give us for the first time reliable information on the farm industry.

Retail trade in farm communities has moved upward.

Older farmers are retiring in large numbers, leaving farms to relatives or selling out. The average age of farmers has dropped.

More land is available for rent or sale, and this fact has already resulted in enlarging the farm unit and in the increased use of mechanized equipment.

The states benefiting most from Social Security benefits are states with the lowest per capita income.

The composition of the labor force has been affected by the increased number of older persons in our society. First of all, a smaller percentage of persons over 65 is in the labor market today than ever before. The change may be attributed, in no small measure, to the nature of the modern corporation. The corporation is a perpetual organization, quite unlike the individual proprietorship. When the proprietor died, or decided to give up the business, his responsibilities to his employees ended. Since a business rarely outlived the normal life span of its employees, superannuation was not a problem; if it occurred, it was handled as a personal matter between the proprietor and the employee. Personal relationships changed with the corporate form of business enterprise. Since the business usually outlived the lifetime of its employees, responsibility for older employees,

and systematic means of maintaining a well-balanced work group, became important aspects of corporate personnel policy. It was not chance nor pressure of organized labor but the nature of the corporation itself which induced the paid managers of business to adopt seniority, pension plans, and automatic retirement.

Now that more people live to be old, and those who are old live longer, larger numbers of workers face an increasing number of years in retirement, during which they depend upon the productive capacity of younger workers. A few figures may serve to emphasize this problem. In 1900 there were 75.9 million persons in the population, 28.4 million of whom were in the labor force. There was a ratio of 167 nonworkers to every 100 workers, and only 4 per cent of the nonworkers were over 65. In 1950 the population numbered 150 million, of whom 62,183,000 were in the labor force, or 142 nonworkers to every 100 workers. But in 1950 about 10 per cent of the nonworkers were over 65. Today, (1957) there are 171 million persons in the population and 70 million in the labor force, or a ratio of 144 nonworkers for each 100 workers, but 11.5 per cent of these are older people. For the past few years the increasing number of women entering the labor market has balanced the rising number of nonworkers, so that the ratio of earners to nonearners has remained nearly constant. But the withdrawal of older workers from the labor market has been greater, percentage-wise, than the increasing number of births. Hence, older persons constitute a higher proportion of all nonworkers than ever before.

The impact of the aging population on employer-employee relations has been dramatic. Beginning about 1875 a few companies developed pension plans for their employees. Tax legislation and wage controls during World War II led to an increased number of plans, but the new importance of the older worker's place in industry was portrayed clearly as pensions and retirement became the central issue in collective bargaining between coal-miners and mine-operators in 1946, between steelworkers and steel-mill owners in 1949, and between automobile workers and automobile manufacturers in 1949 and 1950.

The pension issue could not be negotiated as easily as straight wage issues. Pension costs and administration are complex matters and constitute long-range commitments as wage adjustments do not. Actuaries, trust officers, insurance-company representatives, and economists were brought to the bargaining table. Whether engaged in bargaining or serving only as consultants, their presence forced the parties to pay attention to detailed facts and figures. Out of pension bargaining came a more mature relationship between employers and unions, the long-term contract written for five, three, or two years being one evidence of the mutual recognition of the necessity of living together.

As the numbers of retired workers from mine, mill, and plant have increased, unions and managements have extended the conflict for workers' loyalty to the ranks of the retired. Unions are now sponsoring educational and recreational programs for retired members. Original plans of unions to permit retired members to retain active membership status have been cast aside, but unions are serious in their efforts to assist workers in maintaining an active and enjoyable retirement. Companies also, by sponsoring retirement-planning and retirement-counseling programs, are trying to maintain constructive relationships with their older employees despite the often negative reaction by employees to automatic retirement policies.

Unfortunately it is not possible to report widespread efforts on the part of the employers to make employment opportunities available to older persons in the labor market. We have been experiencing a shortage of labor for the past several years, particularly of skilled employees. Deferred retirements are not infrequent. Nevertheless, the policy of automatic retirement at a fixed age has seemed to increase. The continuous decline in the number of persons over 65 in the labor force was checked in 1956, for the first time since the close of World War II. Whether the recent extraordinary demand for labor was the cause of the slight rise in employment of older workers is difficult to determine. The cause might have been simply the relaxation of the retirement test under OASI, which now permits much greater employment without loss of benefit rights than the previous test.

The controversy over automatic versus flexible or selective retirement plans continues to occupy the thinking of older workers, business executives, and trade-union leaders alike. The experimental work of a number of companies with gradual retirement plans and temporary

service contracts is commendable, but these are not the solution of a worker's need for constructive activity in the inevitable years of retirement. Imagination is needed to assist industry in finding ways of making profitable use of a vast and increasing labor reserve. Ideas are not enough, employers must be found who will do a little experimenting in unorthodox use of men and women past 65 to prove that these people can produce enough to earn their wages. Simultaneously, increasing efforts are needed to educate older people for more satisfying uses of leisure time.

REFERENCES

1. Anonymous. Farmers, new cash crop, Social Security benefits. *Business Week*, August 3, 1957, pp. 88-90.
2. Myers, Robert J. Old Age and Survivors Insurance finances. *Social Security Bulletin*, September, 1956, p. 16.

# THE IMPACT OF AGING ON SOCIAL INSTITUTIONS

CLARK TIBBITTS
*(Special Staff on Aging, U.S. Department of Health, Education, and Welfare)*

Biologists and behavioral scientists have been at work for some time in an effort to discover and systematize knowledge with reference to the process of aging as it affects the individual. While it has been recognized that there are cultural and societal determinants of aging and while many social, economic, and health programs have been developed to meet the needs of older people, relatively little systematic attention has been given to aging as a sociocultural phenomenon or to the effects of population aging on the culture and on the structure of society itself.

Aging as a sociocultural phenomenon may be considered from three points of view. First, the culture and society may be examined with reference to their roles in creating the phenomenon of population aging, that is, as factors in population growth, in the extension of life, and in altering the position of older people in society. Second, cultural norms and societal behavior may be examined as elements in the complex of factors involved, along with biological and psychological factors, in the aging processes of the individual. Third, attention may be focused on the manner in which growing numbers of older people who are completing, or who have completed, traditional adult roles react reciprocally upon and effect changes in, the culture and in the organization of society. While these do not represent wholly independent approaches, the concern of this paper will be on the impact of aging upon some of the institutional and organizational aspects of society.

## WHAT ARE SOCIAL INSTITUTIONS?

It seems well, first, to give some consideration to what an institution is. Sociologists and anthropologists have developed the concept to identify certain organized, established ways of meeting life situations. Institutions, they say, represent patterned forms of adjustment which evolve out of men's efforts to satisfy their basic needs within their particular environments. As defined by some, only the most important group habits which are found generally in a large number of cultures and which have existed for long periods of time are institutions. Thus, the principal institutions are identified as economic and religious institutions, the state, and the family, which have evolved out of men's efforts to satisfy their needs for security, food and shelter, sex expression, and training of the young (7; 8; 10, ch. 3).

Institutions become part of the culture of a society and are passed on from generation to generation. Important for the present consideration is that institutional patterns define the expected behavior of the individual and influence the organizational components and structure of the society itself. Institutional functions, such as obtaining food and shelter, are carried out through a variety of organizations, group relationships, and defined ways of behavior. Social value becomes attached to behavior which conforms, and individuals who conform are given status by the group.

Since institutions and societal forms grow out of efforts to satisfy needs within a particular environment, it follows that they may be modified, or conceivably even abandoned, should there be sufficient change in either the needs of individuals or in the conditioning environment. There is no evidence that aging has altered the nature of basic human needs, but important aspects of the phenomenon of aging are certainly consequences of major changes in the material environment. I refer, of course, to the discoveries, inventions, and technologies which have resulted in the extension of average life expectancy and in the ways of making a living through industrialization of the economy and the urbanization of society (11).

Institutions, by their nature and definition, change very slowly. On the other hand, methods of achieving the goals defined by institutions may change more rapidly. That is, social organizations do frequently alter their programs by adding, changing, or even dropping functions within the established institutional framework. Change, however, often creates problems because it conflicts with established

interests, upsets long established habits, and may interfere with status roles. Moreover, while certain changes may be desired, such as reduction of the input of human energy required to make a living, consequent effects, such as enforced retirement from paid employment, may not. Thus, the unforeseen consequences of some changes are often disturbing to long held social values and individual or group interests.

With this brief review of the character and roles of institutions, let us turn to a consideration of some of the impacts of aging on the family, on the state, and on organizations related to the use of leisure time.

## AGING AND FAMILY RELATIONSHIPS

The family is one of the earliest and the most universal of all institutions. It has provided opportunity for sex expression; it has been the medium for perpetuating the group and training the young; until recent times it has been the basic unit in the economy; and it has generally provided a haven for the old. The family has, of course, taken various forms, dependent upon the traditions of the group, the nature of the environment, and the type of economy. While the position of older individuals has not always been idyllic, most societies did make provision for the well-being of the old. This was not difficult when adult roles were interrupted by early death for most people, and when the family or household was responsible for a wide variety of functions including provision of food and shelter, training and protecting the young, and caring for the sick. In general, useful roles were available for the able-bodied and able-minded of all ages.

One of the outstanding effects of the extention of life and of the mechanization of the economy is proving to be the breakup of the household or kinship group or the extended family relationship. The small, conjugal family of two adults, or adults and young children, represents the natural adaptation to our industrialized, urban, and increasingly mobile society. The transfer of economic activity and of many other functions from the home to factories, business establishments, community agencies, churches, and Sunday schools has all but removed the need for household services of children and older people alike (6).

This shift of functions away from the household has an important positive aspect. It is providing middle-aged men and women an average of eleven years together (and many more years for one or the other) beyond the completion of parental responsibilities — years with opportunity for independence, for resumption of earlier interests, and for the development of new life goals and pursuits (4, ch. 3).

There are also negative aspects in the completion of parental roles, and these are attracting far more attention than the positive aspects. Removal from the household constellation deprives the older person of an important source of affection, love, respect, and opportunity for self-expression and usefulness. The deprivation appears to become especially acute for those unable to develop other interests when death comes to the spouse; and to those who suffer from an infirmity or permanent disabling illness. To return to the home of children (and about one-fifth have no children to whom they can return) becomes increasingly less feasible with divergence of interests between children and parents, with geographic separation and mobility, and with shrinking size of dwelling accommodations. Most of the observations which have been made indicate that three-generation living produces conflicts and that it tends to be eschewed by members of all generations involved.

Efforts to define new intergeneration roles for older people have not been particularly successful. Most working mothers appear to wish to manage their own households even though outside employment makes their dual role a difficult one. The role of grandparent as a teacher and bearer of tradition seems to have little value in a rapidly changing culture which emphasizes individual accomplishment and adaptability to change as opposed to perpetuation of family name, occupation, and position in the community.

The impact on the middle-generation family is proving to be almost equally great. Society is moving in the direction of freeing young adults from responsibility for financial support of their older parents through the establishment of superannuation pension and payment schemes, through encouragement of relatively independent intergeneration living, and through some provision of facilities for housing and long-term medical care for the aged. At the same time there is a good deal of ambivalence. Most states require adult children to support their parents if they are able to do so and if parents need support. Middle-generation fam-

ilies are quite commonly urged to provide shelter and care for infirm and severely disabled older relatives if they can (1). Long-time and deeply imbedded values of filial obligation and respect are cherished by members of all generations even when the possibility of achieving them ceases to exist. Thus, considerable feeling of guilt has appeared among those of all generations involved. The problem is aggravated by the declining size of the family, leaving fewer children to share responsibility, and by the increasing length of life which extends the duration of the period of need.

The conclusion is that population aging is straining the capacity of the family or kinship group to satisfy the needs of the older generation. It may be that the family as an institution is being deprived of its function as a locus and protector of the older generation. If this is the case, what institution or institutions will replace the family in enabling the older individual to meet his needs? What new roles will be defined for older people comparable to their earlier roles as family members? Are there any intergeneration relationships which will prove to be possible, useful, and mutually satisfying? What kinds of living arrangements will meet the diverse circumstances and needs of older people, particularly the widowed, infirm, and disabled? What further means will be devised for the financial support of older people so that the burden does not fall unequally upon middle-generation adults who are trying to provide the best possible advantages to their own young children? Answers to these and other questions will determine the extent of the impact of aging on the family institution and its forms and relationships.

## AGING AND THE STATE

The state or government agency appeared realtively early in human history as a device for handling problems, meeting crises, and exercising control over matters which were beyond the range of family competencies. Functions of the state have grown and expanded as populations have become larger and as cultures have become more complex. Many social developments have left their impact on the form and range of government activity. Among the functions taken over by government from the family, to greater or less degree, are protection of person and property, education, public health, provision of economic security in old age, and recreation.

Within one generation, we have seen considerable impact of population aging on the activities of governments at all levels. Organized community facilities and services for relatively small numbers of the indigent, the homeless, and the chronically sick have existed for many years. The first great extension of governmental service on behalf of older people in modern times was the development of schemes for the support of superannuated workers and their dependents.

The next major extension has come in the field of health. Larger numbers of people living into the later years have correspondingly increased the number of people with health problems and, together with the control of infectious diseases, have changed the national patterns of illness. One-half of all deaths are now of persons 65 and more years of age, and 87 per cent of all deaths are caused by chronic disease. In 1900 only 24 per cent of deaths were of persons 65 and over, and deaths from chronic noninfectious diseases accounted for less than 40 per cent of all deaths (9, p. 30). Thus, the predominant health concern has become that of prevention, treatment, and restoration with reference to long-term, chronic, often degenerative diseases.

Governmental intervention is taking a variety of forms, including performance and support of medical research; provision of funds for construction of research, teaching, and medical-care facilities; support of training programs; and, in some cases, provision of, and payment for, direct health and medical services.

Housing is another area in which the state has begun to show its capacity for adaptation and expansion. Particularly in Western Europe and more recently in the United States, government has found it necessary to build, or to assist in building, dwellings for well older people of low incomes, as well as congregate facilities for those who require protected living arrangements. A still more recent action is the provision of medical care, household help, meals, and other services to older people in order that they may continue to live in their own homes for as long as possible.

One entirely new development in government is the state and local commission or committee to stimulate, coordinate, and assist the development of facilities and programs for older persons (7). In cutting across the operating

boundaries of existing agencies, these organizations reflect the interrelatedness of the various aspects of aging (although they also create problems of administration and functional overlap with established departments of government).

While not a part of the structure of government, many voluntary organizations have appeared over the years to assist people in meeting their needs. Many of these agencies, such as service clubs, social-welfare organizations, and labor unions, are having to modify their programs in order to serve the rising number of older persons. It appears, also, that the magnitude and the complexity of the phenomenon of aging are bringing many voluntary organizations into closer working relationships with agencies of government. This is a clear development in several of the countries of Western Europe.

From this brief review, it will be seen that the state and voluntary institutions, together with the numerous organizations through which their functions are carried out, are undergoing considerable change in response to the growing population of older people. Many problems remain to be solved. How far should the state go in providing services for older persons? What are its ultimate functions? What are the responsibilities of various levels of government? What is the proper division of functions between statutory and voluntary agencies? How much service can be afforded? How should services be financed: out of individual income, from insurances, or on the basis of community support?

## PATTERNS FOR LEISURE: A NEW INSTITUTION?

Perhaps the outstanding aspect of aging is the relatively earlier completion of traditional adult parental and work roles, accompanied by large increases in the amount of free time available in middle age and particularly in the later periods of life. In earlier economies, free time or leisure was sought as opportunity for rest and recuperation. In today's machine economy, free time has become an end in itself—time to be employed and enjoyed for its own sake.

One of the principal questions in the field of aging is: How shall this free time be used? Merely filling it with relatively aimless pursuits does not seem to be enough. Many older people who tend to withdraw from work activities and from people and to occupy themselves with television and radio, newspaper-reading, playing games, and puttering around are keeping occupied, but the evidence is that a good many of them are not satisfied (5). On the other hand, those with many interests, who are participating in organizations and who are finding ways to be useful are reporting middle age and later maturity to be the most enjoyable periods of their lives. If further research shows that these indications can be generalized, then there is need for systematic effort to develop opportunities which will enable all those who wish to do so to find new, active roles.

It will be recalled that institutions come into existence to satisfy human needs. Hence it becomes important in searching for new roles in the later years to determine what needs appear to persist throughout the life cycle. While there have been many such formulations, an especially useful one in the present connection would seem to be that developed by Havighurst and Friedmann (3, ch. 9) in connection with their studies of work and retirement. On the basis of satisfactions reportedly derived from work, these investigators concluded that retirement should offer an activity routine, opportunity for personal contacts, status derived from performance of a culturally defined role, perhaps opportunity to serve others, as well as intrinsic satisfaction in the activity itself.

Now, after a decade or more of experimentation and with at least common-sense efforts to relate their offerings to needs, varied community agencies are undertaking to provide opportunities designed to enable middle-aged and older individuals to develop new goals and roles which it is hoped will give significance to the later years of living. Some adult-education agencies, including libraries, are making special efforts to design programs of guidance, general and vocational education, and other experiences especially aimed toward individuals in the upper age groups. Educational and other agencies are giving instruction in the arts and crafts and are trying to assist the efforts of some who wish to pursue these skills. A wholly new agency, the activity center, has come into existence to offer opportunity for socialization, recreation, and related activities. Churches, community centers, and recreation agencies are modifying their programs in order to sponsor golden-age clubs and other group activities. Some volunteer bureaus and operating agencies, like the American Red Cross, are recruiting middle-aged and older people who wish to develop new

roles in voluntary service. Chambers of commerce in some areas are advertising their communities as retirement centers and are encouraging local agencies to make them attractive as such. This is, of course, only a small indication of the number and types of organizations which have become involved in catering to the leisure-time needs of older persons. Presumably they are meeting needs because many of them are reporting stable or rising rates of participation.

A major question not thus far answered is whether these uses of leisure time will be accepted as culturally-valued activities and whether society will accord status to those who seek new roles in these areas of noneconomic activity. Society has defined, and given its approval to, work and family roles associated with economic production and with training the young. Will it eventually define and give its approval to roles which lie totally within the area of the use of free time? If so, it will represent a fundamental change in social values and the creation of a new social institution or institution complex. Further, is this a development which should be consciously encouraged, or should it merely be allowed to evolve, as is often the case with social adaptations to change? There is some indication of impatience on the part of organizations of older persons who seem to wish to expedite the process.

One final question. Any new socially defined pattern of behavior must necessarily represent a harmonizing of the interests of those who are to be served directly and the interests of other groups in the population. If an attempt is made to institute noneconomic roles for increasing numbers of older persons, what difficulties may be anticipated as a result of conflicts with the objectives and prerogatives of other groups? Clearly one such difficulty has already appeared, namely, that of the costs involved in permitting the withdrawal of older people from the productive economy and in providing the facilities and leadership required for the operation of leisure-time programs. Perhaps there are some free-time or retirement activities, such as voluntary community service, which can be made to serve the purposes of the total group even though they are noneconomic. There are, of course, many such services being performed today, such as painting, writing, and motion-picture production, which, while noneconomic, nevertheless give status.

## CONCLUSION

I have undertaken in a preliminary way to suggest the nature of the impact of aging on some of the institutions and organizations of society. From this brief review and from other papers which have been presented during this series of meetings, it seems clear that the impact is already far reaching and that a systematic analysis of its nature and direction would be of considerable value. Such an analysis will constitute a major part of the *Handbook on Social Gerontology* which is now under preparation as one phase of the Inter-University Institute for Social Gerontology.

## REFERENCES


1. Bond, F., & Others. *Our needy aged.* New York: Henry Holt, 1954.
2. Council of State Governments. *The states and their older citizens.* Chicago: Author, 1955.
3. Friedmann, E. A., & Havighurst, R. J. *The meaning of work and retirement.* Chicago: Univer. Chicago Pr., 1954.
4. Glick, P. C. *American families.* New York: Wiley & Sons, 1957.
5. Kutner, B., & Others. *Five hundred over sixty.* New York: Russell Sage Found., 1956. Part II.
6. Moore, W. E. The aged in industrial societies. In *The aged and society.* Champaign, Ill.: Industrial Rela. Ass., 1950. Pp. 24–39.
7. Ogburn, W. F., & Nimkoff, M. F. Social institutions *and* Social change. In *Sociology.* Boston: Houghton Mifflin, 1940. Parts VI and VII.
8. Parsons, T. The problem of controlled institutional change. In *Essays in sociological theory.* Glencoe, Ill.: Free Pr., 1954. Pp. 239-241.
9. President's Commission on the Health Needs of the Nation. *Building America's health.* A report to the President by the Commission. Vol. I. Washington: Government Printing Office, 1951. Figures for 1956 supplied by the National Office of Vital Statistics, Public Health Service.
10. Simmons, L. W., & Wolff, H. G. *Social science in medicine.* New York: Russell Sage Found., 1954.
11. Tibbitts, C. Retirement problems in American society. *Amer. J. Sociology,* 1954, **59,** 301–308.

# SOCIAL WELFARE SYMPOSIUM

## ASSESSMENT OF COMMUNITY WELFARE PROGRAMS FOR THE AGED

ELLEN WINSTON
*(North Carolina State Board of Public Welfare)*

Over the last few years there has been growing momentum in social-welfare planning for our older citizens by both governmental and voluntary organizations. There are well-recognized reasons for this increasing emphasis. Foremost is the attention being directed in many areas to the growing number and proportion of older people in the population. The impact of population trends is being felt so widely that many organizations are focusing on the older age segment, much as other groups focus on children and youth. A second factor is the change in family patterns and living conditions so that aged individuals have a changing role in family life. During this same recent period there has been substantial development of social-welfare services geared to the older age groups under both public and voluntary auspices. Particularly important in this connection has been the development of programs for greater economic security for older individuals, as employment opportunities have been declining. Because of the widespread interest, the literature has been increasing rapidly. Books, articles, pamphlets, and reports of conferences and statistical summaries are so numerous that one cannot pretend to summarize even the major contributions (5).

The public assistance program established under the Social Security Act in 1935 and as substantially amended, with the resulting large number of persons receiving Old Age Assistance, focused attention as never before upon the great numbers of older people with insufficient incomes. These people have come, and continue to come, to social agencies for financial assistance and other services. The program of Old Age and Survivors Insurance inaugurated at the same time set the age for beginning eligibility at 65 years, just as that age was set for eligibility for Old Age Assistance. Recently we have the 62-year option for women. Nonetheless, we have the very real problem of an arbitrary age limit with respect to income-maintenance programs. This, in turn, has affected our approach to other programs and services geared particularly to the needs of older people.

We have seen the OASI program increasing sharply in recent years in terms of numbers receiving benefits and the total amounts of money involved. Along with the expanded coverage of Old Age Insurance, there has been relatively lesser need for Old Age Assistance. However, because of population increases, the numbers receiving Old Age Assistance are expected to continue at substantially the same, or a slightly decreased, level for many years to come so that "five years from now, even with the increasing effectiveness of insurance, we will have nearly as many people getting some old-age assistance as we do now — perhaps 200,000 less than the 2.5 million today. The number of the aged will increase by 1.5 million, and as a percentage of all aged, the old-age assistance load may drop by about 15 per cent, but the absolute number . . . will not greatly decline" (4, p. 87).

Actually, in terms of income-maintenance programs and other services to be discussed hereafter, the parallelisms are far greater than any differences between programs under social-welfare auspices for older people and those for the younger age groups. The most striking differences in the development of programs perhaps are in those which are focused specifically upon employment. From the point of view of social welfare, this similarity in types of services for various age groups is extremely helpful, since it means that what has been learned in the operation of programs for younger age groups frequently can be transferred as basic experience for a newer program focusing on the older ages.

### EVALUATION OF RESOURCES

In evaluating the adequacy of the social-welfare resources of a community, the total

needs of the community must be studied in relation to existing programs, and appropriate plans made for meeting all social-welfare needs insofar as possible. We do not believe in segregating out a particular age group for attention, to the neglect of other groups or to the neglect of total planning for the community. Actually when there is emphasis upon a specialized program or upon a particular group quite apart from other community needs, the program is likely to have slender roots in the community or to stand out as an independent effort substantially unrelated to the ongoing pattern of community services. In general we make progress most effectively as we seek to strengthen all essential services and as we provide sound foundations for meeting varied community needs. We must be concerned about raising the level, as it were, of all welfare programs so that we make social progress on a wide front rather than concentrating in too specialized areas. This applies not only to the social-welfare field and its various interests and emphases. We find also that, unless we are concerned in community planning with health and education and recreation, we cannot make as effective progress as we would like in our own area of responsibility. This is not to overlook the practical problems involved and the necessity for priorities. A timetable based on an overview of community needs and resources is one thing; focus on a special group while failing to recognize other community needs, quite a different one.

## RECENT DEVELOPMENTS

So far as social-welfare programs for the aged are concerned, we are moving in a variety of directions. Reference has already been made to the two large-scale economic-security programs. In recent sessions the Congress has strengthened both of these programs so that payments to individuals receiving either Old Age Assistance or Old Age Insurance have generally been increased. Even with these increases, the income available to thousands upon thousands of our older citizens remains far below the amounts needed for even a minimum health and decency level of living. In many states, due to lack of adequate state and local funds for matching purposes, Old Age Assistance payments continue to be far too low. Also OASI benefits for retired workers who had low earnings are at best insufficient to meet minimum needs. Hence more and more people are receiving funds through both programs. Continued study is being given by governmental agencies to the proportions of beneficiaries of Old Age Insurance who must have their monthly payments supplemented by Old Age Assistance—a trend which will become of increased importance in the years immediately ahead.

Another major amendment to the Social Security Act with respect to the aged, enacted in 1956, was provision for "a description of the services (if any) which the State agency makes available to applicants for and recipients of Old Age Assistance to help them attain self-care." While any number of state public welfare programs had placed some emphasis in this area, this was concrete recognition on the part of the Congress and the Department of Health, Education, and Welfare that a broad service program is an essential concomitant to the program for financial assistance. Self-care can, of course, mean many things. Generally, however, it relates to those programs of state and local public welfare agencies which contribute to the overall well-being of the individual and help him to make as effective use as possible of his own resources. Impetus is being given through this amendment to more specialized services under public welfare auspices for older people in general, not merely those who are eligible for Old Age Assistance.

In still another direction the 1956 amendments to the Social Security Act crystallized directions in which we had already been moving with regard to welfare programs for the aging. I refer to the amendment with respect to medical or other types of remedial care, whereby the federal agency will help pay for such care up to one-half of $6.00 multiplied by the total number of individuals who received Old Age Assistance in a state during a given month. Making provision for medical care outside of the subsistence grant is stimulating the development of more adequate medical-care programs. We still have a long way to go before persons who must have financial assistance in meeting health needs receive all of the assistance required, but this amendment represents substantial progress. At the same time public health with respect to the chronic diseases and nutrition are being strengthened under federal and state impetus.

The several social-welfare programs briefly

reviewed here are in effect in differing degrees in the states. At the same time specialized programs of many types are beginning to be provided under public welfare auspices. Because housing is one of the more serious problems for older people, particularly those with low incomes, there has been particular interest on the part of public welfare agencies in various types of domiciliary or sheltered care. These programs have usually been developed to meet the needs of persons who, no longer able to maintain their homes, need protected living arrangements. These programs have been developed also because of the demand for an alternative to institutional care for individuals not requiring active treatment programs. Since these are normally programs based upon state legislation, they have been developing at differing rates but with a substantial core of common objectives to meet common needs. In order that there may be adequate standards established for such care, the National Committee on Aging of the National Social Welfare Assembly has placed particular stress upon this area. With our current widespread interest in domiciliary care for older people, we fortunately can point to the pioneer examples of group care for the aging, which, for fifty years or more, and usually under religious auspices, have shown the way.

Also, taking cognizance of the demand for housing suitable for elderly persons in independent living arrangements at a price they can afford to pay, the American Public Welfare Association has issued a policy statement, "Public Welfare and Housing" (2). This of course is but one illustration of increasing emphasis on this facet of the need. There will inevitably be growing emphasis by public and voluntary agencies upon better ways for meeting housing needs, whether in individual domiciles or in group care (3, *passim*).

Slower to develop, but receiving increasing attention, are those specialized services which help older people to continue to live independently and more happily in their own homes. One of these developments is the emphasis upon homemaker service, upon providing, on a recurring basis, sufficient assistance with the activities of everyday living so that it is not necessary to uproot the elderly person. That we have not moved more rapidly in this area has certainly been due, on the one hand, to lack of funds to provide this specialized type of service. On the other hand, perhaps we have also been slow to catch the vision of what this type of program, already so well demonstrated with respect to children, can mean to the aged. However, this type of service has been made available to a sufficient extent through both public and voluntary programs to demonstrate convincingly its importance in comprehensive planning for services for older people. Until we help more older people remain in their own homes or return to their homes when able to do so, we shall have a tragic gap in our pattern of available services.

Also in the category of helping individuals in the older age brackets in terms of their adjustment are the day centers, particularly associated with the large cities such as New York, Cleveland, Chicago, and San Francisco. Here too, while the activities and programs differ, we have a type of development which has a parallel in our planning for day care for young children.

There are many types of specialized programs associated with an individual community or a particular service group in a community that cannot be enumerated here. Those which have been enumerated are, by and large, the major developments in the social welfare field, especially under public auspices, in terms of making available needed services for older people. Basic to their administration and to their effectiveness in individual cases is the level of casework service provided by the sponsoring agency. Providing financial assistance, as well as all the other social services, should be seen as individualized skilled services by qualified caseworkers, with the use of other professional disciplines as required. That we have such a shortage of really qualified staff to work with older people is a major deterrent to program development.

## BASIS FOR PLANNING

The question has been raised: Do we need to plan for all older people in a community, or must we learn to think more clearly about the categories of people who need help? I would question both approaches. If we plan for all older people, we have no sharp focus as a basis for program development. If we focus on categories of people, we are really acceding to the framework which law has laid down. It is actually far sounder to think in terms of the various types of help that people need and how

these services may be made available to persons with specialized problems. After all, aging is an ongoing process, and persons at different ages may have differing needs which social-welfare programs should be set up to provide. One of the real dangers in attempting to provide more effectively for the needs of older people is that we focus so much on the age group that we do not emphasize appropriately the particular services we are set up to offer—services that are perhaps needed most by persons in the older age groups and that hence take on particular characteristics because of the groups which seek and use such services. When we do not have the resources to meet the particular needs of older persons, certainly we need to establish new programs and services or to expand existing ones. Such programs need to be integrated into a total community program as we strive better to integrate older people into the total life of the community.

Most of us in the social-welfare field are gravely concerned over the inadequacies of present services, both public and voluntary, that are available to meet the special needs of older people (1). While some workers have perspective over a period of years so that they see the tremendous gains that have been made, we realize the deficits in providing truly adequate services. The reasons are not new. We lack sufficient funds, whether the funds come through federal, state, or local appropriations or through voluntary contributions. We lack adequate staff, not only staff with generalized training in social work and in allied fields, but particularly staff who have some special knowledge with respect to the processes of aging and of how the older years bring special needs or an intensification of certain types of needs. As in other programs, too, we find barriers in terms of lack of public understanding, perhaps too little imagination in providing some types of services, and always questions of whether even existing resources are being used to the full. However, in none of these problems is there anything that is particularly characteristic of services to older people. We have the same problems around adequacy of services for all age groups. The fact that we have come more lately to recognize, or at least to plan constructively for, the special needs of older people has made the development of service programs to meet the demand a more recent phenomenon in most communities.

## MEASURES OF EFFECTIVENESS

As we look at the vast pattern of services now being provided to older people, we must constantly be concerned with measures of their effectiveness in meeting the particular needs they are set up to serve. For some of these programs the degree of adequacy can be very definitely measured. In those programs designed to provide basic economic security, we have only to look at the published data to realize in how many states average Old Age Assistance grants, and even Old Age Insurance payments, are insufficient to provide for an acceptable level of living. When we take into account medical needs of older people and how they are being met, we have another measure of inadequacy in many states, but also adequacy in a growing number of states.

In the field of housing we can also be quite specific in certain measurements. We know, for example, that when it comes to licensing standards for domiciliary care or in the nursing-home field, we have a great distance still to go in order to guarantee that adequate standards are met. In some cases this is due to lack of basic legislation or of competent staff, or it is due to standards that either do not exist or have been set too low.

Our position in the area of basic casework services is much the same as that in the total social-service field. How does one measure effectively casework services? Do our records show constructive movement in the individual case?

Another approach to measuring the adequacy of services is found in the fact that so many of the specialized programs are located in a few large urban communities, whereas it is reasonable to expect that these needs exist also in communities of comparable characteristics generally across the country.

## PUBLIC AND VOLUNTARY AGENCIES

In services to the aging, as in all other welfare programs, the question of the respective roles of the public and the voluntary agencies inevitably arises. Certainly there is no difference in this respect in terms of services available to one age group as compared with any other age group. The basic philosophy that now determines any distinctions in roles would, we believe, usually apply in any community concerned with services to the aging. We recognize that private agencies are in no position

to handle the tremendous cost involved in financial assistance for subsistence and medical care of the aging. Also public agencies must administer licensing laws and other types of legal responsibilities. Hopefully, voluntary agencies will increasingly demonstrate nonfinancial social services and recreational and educational programs and, through experimentation, build up the knowledge and skills, the emphasis on good standards, and the community support which are essential to offering specialized services on a broad scale.

## A LOOK AT THE FUTURE

As we look to the future, we realize that the sheer impact of the sharply increasing numbers of older people will have more and more effect upon the demand for specialized services which are particularly geared to meet their needs. We may expect to see increasing supplementation of Old Age Insurance payments by public assistance unless there is a sharp increase in the benefit rates. Certainly persons receiving Old Age Assistance will grow continually older on the average than their present average of 75 years. With an increasing number of elderly people who are very old, the demands for medical care at public expense, whatever the method of payment, must have increased attention.

Present services—in which, by and large, we either help people who can continue to maintain independent lives in their own homes, or we remove them from their homes into some kind of group or institutional care—need to be supplemented on a broad scale by services which will give sufficient help to enable individuals to remain in their own homes. We must give more attention to such programs as homemaker service, meals on wheels, home nursing services, and day centers. We must place more attention upon strengthening the individual family situation so that the elderly person can remain in his own home, either alone or in a family group. Here we have made only the slightest beginning in terms of effective programs.

We may certainly anticipate a wide variety of specialized services undertaken by voluntary agencies or by various organized community groups concerned with contributing to the total pattern of services in their own localities. Since much experimentation, demonstration, and supplementation of large-scale programs is needed, this is a development to be actively encouraged.

The deficit in personnel with special training for understanding the particular needs of older people has been stressed above. We have not yet geared our formal training programs in social work to any extent to preparing people for specialized services to older people. If through specialized training and experience we can build up a large group of persons with special skills in this area, we shall be able to promote more realistic and effective programs to meet the wide range of problems faced by older people. We shall be in a far better position to help promote continued good health and independence, to foster individual dignity and well-being. We shall, in truth, recognize in our older citizenry not only a community responsibility but especially a challenging opportunity.

## REFERENCES

1. American Public Welfare Assocation. *How public welfare serves aging people* (pamphlet series). Chicago: 1954-1957.
2. American Public Welfare Association. *Public welfare and housing.* A statement by the Committee on Welfare Policy. Chicago: 1957.
3. *Architectural Rec.*, **119,** May 1956, 191-226.
4. Ball, R. Social security today. *Public Welf.*, **15,** July, 1957, 87-90, 118.
5. U. S. Department of Health, Education, and Welfare, Committee on Aging. *Aging—a community responsibility and opportunity.* Washington: U. S. Government Printing Office, 1955. This publication supplies a useful bibliography on aging.

# ASSESSMENT OF SERVICES IN THE VOLUNTARY AGENCY FIELD AS SEEN BY A NATIONAL COMMITTEE

GENEVA MATHIASEN

*(Executive Secretary, National Committee on the Aging of the National Social Welfare Assembly)*

I should like to suggest ten criteria for assessing services for the aging in the voluntary field. Because of time limitation I shall discuss only the first five and merely list the others.

1. Are services being developed in proportion to the amount of talk and planning which has taken place and in proportion to public awareness of need?

In a recent issue of the *Saturday Review*, Clifton Fadiman wrote, "One of the marks identifying a revolutionary period is the speed with which a shocking statement changes to a boring one." And a little later in the same article he says, "We delude ourselves into thinking that because we know a thing, we have done something about it: our equivalent of the primitive's belief that to name is to control."

We are undoubtedly in a period of revolution in the voluntary welfare field with respect to services to older people; and we may do well to ponder these words. There has undoubtedly been great progress during the past decade in the amount of discussion about the growing numbers of older people in our country, and the attention given to the fact that this population change means an additional emphasis on social-welfare services for older people. I have been asked to comment on the criteria for assessment of voluntary agencies as seen by a national committee. I suppose the most striking thing about community programs for older people is the vast amount of talk—conferences, institutes, workshops, discussion groups—on every conceivable facet of the needs of older people. Almost without exception, reports of such meetings say that "attendance exceeded expectation and newspaper coverage was good." I am a great believer in the value of meetings of all sorts; and I think we need more meetings on aging in cities and towns, in schoolhouses and churches, in hotels and auditoriums all across the country. But there is a certain danger that people will get bored with all the talk about old age before they do anything about it —or that, as Fadiman suggests, having heard so much talk, the public will assume that surely somebody has the thing in hand; that a problem having been named, those who are responsible for its solution have it under control.

There is also a certain danger in calling attention to the needs of older people on the basis of their proportion in the population. Although the *numbers* of older people will continue to increase, a rising birth rate means that ratios change. Many of you no doubt saw the article in the October *Atlantic Monthly*, entitled, "As the Nation Grows Younger." The article points out that "individually we grow older with ever increasing chances of survival, while collectively we have started to grow younger for the first time in our national history."

In our talk we may have stressed too much the proportionate increase in numbers rather than the fact that the needs of older people are human and individual. It is the function of social welfare never to lose sight of this fact, and to plan its services accordingly.

When we move ahead from the assessment of needs to the provision of social-welfare services in the voluntary agency field, we can be less sure of progress. Dr. Winston says in her paper, "We do not believe in segregating out a particular age group for attention, to the neglect of other groups or to the neglect of total planning for the community." Most of us would agree with this statement in principle. However, if one age group has been consistently neglected, it must be singled out for attention until the social-welfare service structure assumes a more balanced relationship to age and need. Hence I would suggest the second criterion for assessing voluntary service.

2. Are older people getting their fair share of voluntary social-welfare services (and I may say the social-welfare dollar) based on their proportion in the total population and on their needs?

In view of the low incomes of older people, the disproportionate prevalence of chronic illness, and substandard housing among them, it might be fairly assumed that their social-wel-

fare needs are greater than those of other age groups in proportion to their percentage in the population. There is no accurate measurement of voluntary social-welfare services by age group, but the records that do exist are at least suggestive. In June, 1957, United Community Funds and Councils of America issued a report of distribution of funds by community chests and united funds in 255 cities by service areas. The amount allocated for services for care of the aged was at the bottom of the list. Per capita appropriations for all voluntary welfare services in these cities ranged from $2.68 to $5.02. Of this amount, the per capita appropriation for care of the aged ranged from less than one-half cent to four cents. The group of cities appropriating less than half a cent per capita for care of the aged allocated 79 cents per capita for scouting, campfire, and boys' and girls' clubs, and 81 cents for YMCA and YWCA. The 255 cities averaged three cents per capita for institutional care of the aged, as compared with 11 cents for separate children's institutions, and six cents for day nurseries. Another part of the report, showing the percentage increase in allocation of funds from 1951 to 1957, under "Services to Aged," carried the footnote, "Insufficient reports in this field to permit showing of percentage change."

It must be recognized, of course, that older people shared in some degree in allocations for recreation services, settlements and community services, family and child welfare. Such studies as have been made, however, show that in these fields older people are underserved.

One might assume, for example, that family agencies would be devoting a fair share of their casework services to older people. The only survey, so far as we know, which gives any information on the extent of the involvement was made in the spring of 1957 and covered 31 family agencies in the Southern Region of Family Service Association of America. Eighteen of the 31 agencies queried returned the questionnaire regarding the extent and type of services being provided for persons 65 and over. The report indicates that the older clients made up 1.9 per cent of the agency case loads, although they represented between 7 and 8 per cent of the total population in the areas reporting. Agencies reported a case load on a single day of 2,432 cases affecting directly 9,903 individuals. Of these, 140 cases were older people, with 191 individuals involved. However, the report says that "the agencies as a whole believe that there have been significant manifestations of public concern about the aged and their needs."

The same situation, as Dr. Winston points out, is true in providing homemaker services. Though this kind of service would often mean the difference between independence and institutional care, there are few communities which do not restrict this service to families with young children.

Many times space is provided for older people's activities in settlements and community centers only during the hours when it is not needed by other age groups. A good many communities now report camping programs for older people. Yet when you read the fine print, the camp for older people is often limited to perhaps two weeks at the beginning or the end of the camping season, when the children must be in school, and when mornings and evenings are likely to be chilly and it is not so important to escape the heat of summer in the city.

Dr. Winston quite properly deplores focusing "on a special group while failing to recognize other community needs." One cannot help wondering, however, whether it would not be a healthy shock to the community if priority status were occasionally given to older people. Many reasons are given for not providing more service to older people, the most frequent reason being lack of staff and funds. But surely older people, having contributed to community chests and united funds over a lifetime, deserve a more equitable share of what is now available.

3. The third criterion for assessing social-welfare programs for older people is quality. Do the programs for older people have the same standards in physical facilities, program content, and staff as do those for other age groups?

Ten years ago less than half the states had legal requirements for licensure or approval of institutions caring for the aged. In some states voluntary homes are still excluded. When the National Committee on the Aging began its work on standards of care for older people in homes for the aged and nursing homes, a representative of the Children's Bureau pointed out to the project advisory committee that the field of aging was where the children's field was fifty years ago in its thinking about standards.

Recently the National Committee on the

Aging took the first step in preparation of a set of standards for centers and clubs for older people. Although such centers are increasing in number, not more than four or five were planned and built for that purpose. Reports from persons across the country concerned about standards report lack of fire and other safety precautions, steep stairs, inadequate toilet facilities, poor lighting, unskilled leadership. In one community, people from 60 to 80 years of age were enrolled in a camping program which included swimming but did not include the requirement of a physical examination.

A few excellent plants and programs can help show the way. But in far too many places it has not seemed important to apply basic group-work principles in recreation programs for older people, or casework principles in giving them advice, or community-organization principles in planning a program to meet their total needs. This brings us to the fourth criterion.

4. Are the social-welfare services for older people part of a community-wide, comprehensive, and coordinated plan?

As Dr. Winston points out, "Unless we are concerned, in community planning, with health and education and recreation, we cannot make . . . effective progress." I believe it is safe to say that no community has made effective progress without such community-wide and comprehensive planning. While there are notable exceptions, usually over-all planning is considered the responsibility of the community council, a voluntary body which includes in its membership, or is closely related to, public and private social agencies; educational, health, and religious groups; and the general public.

A notable example of such planning is found in our host city. In another city, some 50 agencies belong to the Council on Aging operating under the auspices of the Council of Social Agencies. The groups include not only volunteer agencies but representatives of city and state departments, the housing authority, the county medical society, the manufacturers' association, the federation of women's clubs, and so on. This type of across-the-board representation in planning, we believe, is the key to a satisfactory community program for older people.

In order to do any kind of job, these planning bodies must be adequately staffed. There are in the country today some 480 councils of social agencies or their equivalent. Of these, 95 reported recently that they assign staff responsibility for planning services for the aging. Only 16 of these staff persons, however, give full time; 16 give one-half to full time; 11 give one-fourth to one-half time; 52 give less than one-fourth time. Until more leadership is given to planning on a community-wide basis, only sporadic programs can be anticipated.

5. The fifth criterion has to do with priorities. Are social-welfare services to the aged in the community provided on the basis of urgency of need, or on the basis of the relative ease with which they can be provided or even "sold" to the community?

Without in the least deprecating the excellent recreational programs, those unfortunately (in my opinion) labeled "Golden Age Clubs," which have done so much to enliven the days of older people throughout the country, one must nevertheless raise the question of priority. If we examine social-welfare needs of older people as applied to an individual, the procedure becomes clear. If a community planning group were considering the needs of a person who is lonely, in poor health, living in unsuitable quarters, with inadequate food and clothing, without family or in conflict with his family, it is not likely that the first and even the only suggestion for solving his problems would be to take him to a tea party or to urge him to join a pottery class or even a discussion group. Yet in the mass, this has often appeared to be the case. It can properly be pointed out that many club and other social programs have gone much farther, and also that they have made the older person visible so that his deeper needs could be discovered and met. In too many instances, however, the program for older people has been a Topsy-like growth, rather than a carefully planned development based on priorities.

These are only half the criteria I would apply to assessing welfare services for the aging. The other five can only be mentioned, but at least I should like to list them for the record.

6. Are the programs bold and imaginative, based on current knowledge of physiology and psychology of aging, or are they cast in the traditional mold?
7. If they are planned as experimental or demonstration programs, are they structured with a research component so that they will supply new knowledge to the field and provide for objective evaluation? Do they assure

consistent and comprehensive recording of methodology and results?

8. Are they part of a plan to meet the needs of the total population of older people regardless of income, or do they appeal only to those with low income?
9. Are they palliative only, designed to meet the needs of those who have already reached advanced age, or do they contain within them the seeds of prevention?
10. Do the people in the community know they exist and know how to take advantage of them?

May I suggest that, without an affirmative answer to the last question, the other nine do not matter very much.

# ASSESSMENT OF SERVICES IN THE PUBLIC AGENCY FIELD AS SEEN BY A FEDERAL DEPARTMENT

WILLIAM C. FITCH

*(Director, Special Staff on Aging, U. S. Department of Health, Education and Welfare)*

Dr. Winston's presentation set an excellent background for each of us to examine in the light of the programs and the areas of administration we work in and represent.

My first observation is one of genuine admiration for the outstanding work the public and voluntary agencies are performing. Without minimizing our role in the federal government, I believe a major part of the imagination and leadership is being demonstrated at the state and community levels.

Time will not permit an item-by-item discussion of the points made by Dr. Winston, but without exception the federal government is necessarily concerned with the same problems. In my ten minutes I would like to single out a few points of special significance.

Those of us who have worked in the Social Security program, as I did for about eighteen years, may not be as completely objective as others, but we have strong feelings about the development of the program and its limitations. It was never intended to replace individual savings or initiative. It was meant to provide a minimum subsistence for those in need and to provide a reasonable income to replace the loss of earnings because of retirement or death. With coverage under Old Age and Survivors Insurance practically universal, with disability benefits included in the act, and with the number of beneficiaries under Old Age Assistance decreasing, the original aims are coming closer to being attained. However, the pace of our society has been so rapid and the increase in the number of older persons so great, we must continually evaluate the true effectiveness of the programs and streamline or redirect the emphasis when necessary.

While it is impressive to know that total Social Security payments in August, 1957, were made at the yearly rate of $18,377,000,000, the value of the benefits in relation to the cost of living must be studied. The number of OASI beneficiaries who require public assistance supplementation should be interpreted.

Payment for medical care under the Public Assistance program was a needed addition, but the medical needs of the marginal-income group as well as of all older people must be considered.

The nationwide survey which will start in January—of how the aged get along during the whole period of their retirement—will be significant. It will attempt to find out how long these people stay financially independent, and under what circumstances they get support from their children, from public assistance, or from some other source. Also, the survey will deal with what happens in the case of serious illness and high medical costs, with attitudes toward retirement, and with the full range of problems which confront the aging. Follow-up visits are planned over a twelve-year period.

Independent of this long-range or longitudinal survey, a cross-sectional study of aged beneficiaries, a study similar to the one made in 1951, was started this month. The findings of both studies will do much to shape public and voluntary programs for the aging.

The Department of Health, Education and Welfare and, I am sure, most of the federal agencies would support Dr. Winston's recommendation for a balanced community program that will strengthen all essential services without separation of age groups, young or old. This is equally important in our department and accounts for our continued opposition to proposals for a Bureau of Senior Citizens or a Bureau of Old Age. Our aim is to strengthen all of the programs dealing with the needs of older persons, rather than to create another organization, one that could not hope to include the accumulated competencies represented in the present agencies.

We share also the concern regarding the arbitrary age of 65 as the age to receive benefits and the age generally accepted as the retirement age in most industries. There is growing awareness of the need to offer opportunities, under all programs, on the basis of the person's

ability and need, rather than on the basis of a fixed age—an age which will become obsolete as our medical know-how and technological advancements lengthen the life span.

At the federal level, and as Dr. Winston also pointed out, we become concerned when services needed by any group are available only to those receiving public assistance. This is a challenge to every public and voluntary agency to organize all of its resources and services to meet common needs. These services must also be integrated with other programs, including health, housing, education, and recreation.

There is also reason to question the variation in public programs among the states. This does not rule out the need for local differences, but there should not be any doubt about the availability of services needed by certain age groups wherever they are. These differences were dramatically illustrated last year when we assisted the Senate Committee in compiling its "Studies on the Aged and the Aging." Many gaps and even the complete absence of programs in the field of aging were noted in areas where the needs were known to be urgent.

I can only hope and believe that the lack of well-directed services is temporary and that follow-up studies will reveal a more consistent pattern of state and community activities in proportion to the need.

# ASSESSMENT OF COMMUNITY SERVICES AS SEEN BY A COMMUNITY WELFARE COUNCIL

MILDRED C. BARRY
*(Departments on Work with Older Persons and the Chronically Ill, Welfare Federation of Cleveland)*

Dr. Winston has said: "It is . . . sounder to think in terms of the various types of help that people need and how these services may be made available to persons with specialized problems. . . . When we do not have the resources to meet the particular needs of older persons, certainly we need to establish new programs and services or to expand existing ones."

This is where we start at the local level. What are the needs of people? Do we have services to meet them? If not, how can we establish them and what priority do we give?

We can list needs either in terms of goals or of problems: goals such as economic security, health, adequate housing, satisfying relationships, opportunities for useful and happy living; problems such as lack of adequate income, illness or disability, unsatisfactory living arrangements, loneliness, rejection, unhappiness.

When we examine the needs of older people, we must have a dual perspective. On the one hand, the oldster may have the same problem as you or I, but it may be accentuated with age. His eyesight may be poorer, his economic needs greater, his housing less suitable. Many older persons with a life-history of independence and self-support may find themselves in need of health and welfare services for the first time. Others who have received service may need it continued or expanded. Thus we find a need to provide services for older persons of all walks of life. This may necessitate new patterns of service or modifications of existing patterns.

For example, homemaker service is recognized as being desirable for families in financial and social need. It is not yet widely recognized as also applicable to the older family who could pay for such service and thus be able to maintain its independence.

When we look at need from the other perspective, we view the phenomenon of drastic loss, the result of a concentration of many problems. When a person loses job, spouse, and health within a few months, the burden may be intolerable. Drastic loss may hit whether or not the person is economically dependent.

The community welfare council, if it is to meet the needs of the older persons in the community, must recognize that potentially it is dealing with most of the older population and that problems may be severe and multiple. When we view this totality of need—all the older persons and their assortments of problems—the effect can be staggering. So we reach certain conclusions:

1. The longer a person can live productively and independently, without multiple problems, the better both for him and for society. Therefore, efforts to sustain independent living, to prevent loss and breakdown, and to rehabilitate persons are essential. Community planning must support such efforts.
2. The multiplicity of problems facing an older person, and their deteriorating effect as they accumulate and are prolonged, call for early access to service, coordination of programs, and continuity of care. Our existing patterns of separate agencies and categories of assistance are handicaps. Coordination on both the administrative and the service levels is necessary.
3. The needs cannot be fully met by public and voluntary subsidy. Planning must take into account establishment of self-supporting programs as well as extension of various types of insurance plans, more adequate governmental programs, more effective use of philanthropic funds, and wise use of special funds such as foundation grants.
4. The impact of the problem, coupled with the need for new patterns of service, offer us an opportunity for a creative approach. The problem is large, but so are the resources. We have a vast reservoir from which to draw ideas, workers, and services.

Each community must deal with its own situation in its own way, taking into account its own acute problems, its existing programs, and

the psychological "jumping-off place." But we must all guard against the complacency that comes from establishing just one new service. I get too many letters which read: "We now have a Committee on Aging and we are going to organize a hobby show," or, "We have a retirement community of inexpensive, safe homes." Nothing else! In this business, one new service is just a beginning.

In Cleveland we have in the Welfare Federation two major committees working in this area, the Committee on Older Persons and the Committee on Chronically Ill. Both have many subcommittees. More than 300 different lay and professional persons are working actively through these committees. Many public and voluntary health and welfare agencies, which do the direct service job, are involved. Some of our goals and some of our problems are described below.

We stress maintaining independence, appropriate services, and continuity of care, with the focus upon the individual older person.

In the health field we have the usual urban assortment of general hospitals, clinics, special health agencies, public health and nursing services, philanthropic and commercial nursing homes. Recently we have added two chronic hospitals, Highland View and Benjamin Rose. Several of our hospitals have strong physical medicine and rehabilitation services. We have vocational rehabilitation and sheltered employment. We have, in the Benjamin Rose Institute, an outstanding organization giving comprehensive medical and social services to older persons. We have established a Chronic Illness Information and Referral Center. The Academy of Medicine, the hospitals, health agencies, public and voluntary welfare agencies work together through our channels. For example, a plan was worked out whereby the special health agencies purchase homemaker service through the Family Service Association rather than develop their own programs. The Academy of Medicine is helping finance a directory of chronic-illness services.

We have made only a beginning. We are now trying to get more and better nursing homes. We are trying to extend home care. We have problems such as these: How can we provide better continuity of care and better "flow" for the patient between institutions? How can long-term illness be financed? How can we get adequate personnel? How can we improve standards? What can we do about specific problems, such as providing better care for the chronically ill in the public housing estates?

We are concerned about the living arrangements of older people. We are trying to maintain people in their own homes through homemaker services, home-care programs, friendly-visitor programs, day-care centers, and golden age center activities; but we are hardly scratching the surface in many of these. We work with homes for the aged. Our public housing authority pioneered in developing facilities and services for older people. Our public and voluntary agencies give counseling service to older persons and their families in this and other areas. We are working now on plans to develop independent living facilities on a self-supporting basis for those who can no longer live completely alone in their own homes but are not ready for institutional living. We face many tangible problems, not the least of which is financial.

We are interested in educational and recreational activities for our older residents. We have about 67 golden age clubs, a golden age camp, a golden age center housed in the public housing apartment, a "Live Long and Like It" club sponsored by a public library, a Cleveland Senior Council composed of retired business and professional men and women. We conduct an annual golden age hobby show and an annual conference on aging.

Economic security is also our concern. We have taken active part in trying to get legislation which would remove the $65 statutory ceiling on Old Age Assistance grants and provide a program based on need. While employment opportunities for more older workers are limited, our community provides vocational counseling. We have sheltered shops. We have a Homecrafters Shop which is a sales outlet for products made by handicapped and older persons. Some progress is being made in pre-retirement counseling.

Our efforts are directed also at public education. Newspapers, radio, and television give good coverage and are cooperative in many ways. One newspaper helps sponsor and finance our hobby show; another has held special outings for senior citizens.

In fact, there is widespread community support for activities in the field of aging. One hundred twenty civic organizations cooperate

in sponsoring our conference on aging. Department stores offer space for events. Builders, architects, bankers, and real-estate men helped sponsor a retirement-housing conference. Presidents of business and industrial concerns, as well as other top-notch business and professional leaders, give time and thought to solving our many problems.

This brief look at how one community, through the medium of its Welfare Federation, is trying to develop a program of facilities and services for its older population may illustrate our thesis. The many interrelated needs of older persons call for a wide diversity of services. Some of these we have; others we need to provide. Some problems we do not yet know how to solve. The job requires the help of many resources: tax-supported and voluntary health and welfare agencies, many other organizations and institutions in the community, interested and able citizens. The job also requires coordination and planning and leadership. This the community welfare council should give. And lest it is not clearly implied, the local community job must be tied in with what is being done state-wide and nationally. Lastly, much more research is needed to test and validate our work and to point directions for the future.

In conclusion, let us remember that the why of all this is the individual older person. Each is himself, with his own needs and desires, and our services must be sufficiently diverse and flexible to meet his needs. The cottage in the country does not suit all. But each man is entitled to his dream cottage wherever it may be.

# ASSESSMENT OF SERVICES FOR THE AGED IN RURAL COMMUNITIES

JOSEPH H. BRITTON, Ph.D.
*(Committee for Study of Adulthood, Pennsylvania State University)*

I have been asked to discuss Dr. Winston's paper in light of understanding derived from a study we have been making in a rural Pennsylvania community on the mental health of older persons. In the course of the investigation we have made an inclusive inventory of all organizations and professional persons in the community who could be contributing to the mental-health needs of the older residents of the community. In one part of our study we also asked some 500 adults in this community to tell us what they thought was appropriate behavior for older persons in various situations.

We utilized the community of New Bloomfield, Perry County, Pennsylvania, as our study area. This included the borough itself and the surrounding township and comprised some 2,000 persons. The area is definitely a rural and not a suburban community, one which is not dominated by a metropolitan center. This county is contiguous to Dauphin County, the seat of the state capital, and is part of a tri-county welfare-service organization. I would like to discuss some of the findings from this study as I comment on Dr. Winton's paper.

Actually a considerable proportion of older people in Pennsylvania live in rural areas, and this is even more true for the United States as a whole. Of the 1950 Pensylvania population 65 or over, 71 per cent were urban residents; 22 per cent, rural nonfarm; and 7 per cent, farm (4). For the United States as a whole, 64 per cent were urban, 22 per cent were rural nonfarm, and 14 per cent were rural farm (5). Thus, in the country at large over one-third of older people lived in rural areas in 1950.

I should like to underscore Dr. Winston's comments concerning services which help older people to continue to live independently and happily in their own homes. Our study indicates that older people desire to continue to live independently in their own homes, alone if necessary, rather than to move in with their children or into some other living arrangement. The virtue of independence and self-sufficiency is reflected in answers given to our interviewers. In this part of the study (1, 2, 3) we presented brief descriptions of hypothetical situations to an adult of each household in the community, asking him to suggest appropriate solutions to certain problems of older persons. The responses to this open-end inquiry indicate where the 487 respondents think older people could get help.

The family should help an older couple who is almost out of money (25 per cent of the 487 respondents expressed this idea).

The family should help a woman who is physically unable to do her housework (25 per cent).

An older person who is lonesome would find company in his friends and neighbors (53 per cent).

Friends or neighbors would help a couple who is almost out of money (2 per cent).

Friends or neighbors would help a woman who is physically unable to do her housework (19 per cent).

An older person who is lonesome should join a club or group (7 per cent).

An older person who wants someone to talk with should go to the local "hangout" (3 per cent).

The minister can help an older person who is lonely (53 per cent).

An older person who hasn't felt well for some time should consult the minister (4 per cent).

If an older woman starts acting "queer," her family should consult the minister or pray for her (6 per cent).

An older person who is lonesome should go to see his doctor, lawyer, or a professional person other than the minister (15 per cent).

When a woman acts "queer," she should be taken to the doctor (33 per cent).

A woman whose hands are so badly swollen that she is unable to do her housework should consult the doctor (4 per cent).

When a person has aches and pains, he should consult the doctor (84 per cent).

A couple who is almost out of money could get public assistance (68 per cent).

Submitted as College of Home Economics Research Publication 159, The Pennsylvania State University. Authorized on June 10, 1958, as paper No. 2263 in the journal series of the Pennsylvania Agricultural Experiment Station.

The church or other private organization would offer to help aid a couple who was almost out of money (5 per cent).

A woman who is physically unable to do her housework would be able to get public assistance (6 per cent).

The Red Cross or public assistance would provide funds for a sick man (1 per cent).

An older person who is lonesome should go to an old folks' home to live (2 per cent).

The following comments indicate a different approach to problems of older persons, an approach which might be thought of as less constructive and less specific.

A man who doesn't feel well should keep still and just stand it (1 per cent).

Sometimes when a person doesn't feel well, imagination can be the trouble (13 per cent).

A woman who is physically unable to do her housework should get some help (58 per cent).

A woman who is physically unable to do her housework should let the job go or get a smaller place to live (15 per cent).

Except for the public assistance program, in almost no instance is a social-welfare agency mentioned for help, though such services are available. The services of two agencies serving families and children are available to residents of this area. A state mental hospital is not far away. There is a school psychologist who serves this community. None of these agencies is mentioned by these rural residents as a potential source of personal help. Our analyses show clear relationships between the opinions of the respondents and their age, occupation, education, and length of time lived in the community. To a statistically significant extent, the less well educated persons in lower-status occupational groups, often the older persons themselves, less often mention professional help, even that of the minister or the physician. They are more likely to take the attitude, "That's what you expect in old age; you and the family just have to put up with such problems and do the best you can."

An inventory was made of organizational and professional services for older persons in this rural community. Interviews with an officer or leader of each club or organization were designed to reveal the extent to which older people participate in the activities, the extent to which the organizations' programs are designed especially for older people, and any special advantages or disadvantages the leaders saw in older people. These results show that older persons are not thought of as a special group apart from others in the community, that most organizations are geared to particular programs rather than particular people. To the extent that an older person is interested in a group's activities and is able to participate, he is free to do so.

The leaders named a number of advantages they felt older people present, such as experience, time, and some special interests and talents. In no case did it appear that the leaders were unfriendly or antagonistic toward older people; they simply had not given the aging much thought. Once they got to thinking, they became more interested and almost enthusiastic. Incidentally, since these interviews were gathered (but not necessarily as the result of them), a group has been organized especially for older people—one in which the chief interest, I understand, is reminiscing. Except for the historical society and one or two Sunday school classes, older persons do not appear to be thought of as especially important or dominant in the organizational life of the community. Special consideration is sometimes given to the needs of older persons by the leaders of organizations in this community—in terms of convenient times and locations for groups to meet. Some leaders did speak of older persons' alleged conservatism, but one leader said, "Persons like Mrs. X [an older person] give us courage to live and work. She's an example and a great inspiration to all of us."

So far as professional services are concerned, professional persons in the community were also contacted—physicians, ministers, lawyers, public assistance workers, insurance brokers, the school psychologist, plus representatives of the State University extension program, social and psychiatric service agencies in adjacent Dauphin County—persons or agencies which directly or indirectly could possibly be serving older people in the study area. These workers discussed their services in terms of helping older persons with problems of overcoming fears and emotional insecurity (some persons feeling lonely and unwanted, or fearing physical illness and its resulting dependency), regulating activity in relation to health, providing legal and financial advice. Most frequently mentioned among problems to be solved are those of economic insecurity. Excluding the state mental hospital, the two social and psychiatric service agencies whose services were available

to the community reported only four older persons from the study area coming to them for professional help, and all four had come not for personal help but for aid for their children or grandchildren.

A word about the community and the 145 of the 177 residents 65 years of age and over, whom we studied more intensively. It appears that older people have a significant place in the community and that many of them are maintaining good adjustment in their later years. This rural community seems to be a safe and favorable place for retirement for persons who have lived most of their lives there, less favorable for others who move in. It also appears from our data that there are a number of older persons in the community who could benefit from modern social-psychological services for the aging.

In view of the fact that personal and financial independence and self-sufficiency in general are valued so highly in this community, it is probably true that this orientation provides an additional source of anxiety for the older person. In turn, more responsibility is put on lay leaders and professional persons, who are not specifically trained in helping others with personal problems, to be of such aid. But even this principle is not clear and simple. Some young seminary-trained ministers in the study community registered with our interviewers the complaint, in effect, that while older people did seek their counsel on religious matters, they did not reveal to the minister problems in which personal counseling might have been of assistance. It probably is true that older persons in the community still think of the minister's role as limited to performing the rites and interpreting the doctrine of the church. The minister, on the other hand, is apparently trained and feels obliged to help his parishioners in other areas of life as well.

The cultural lag illustrated here and the apparent stress on independence and self-sufficiency probably make it impossible for the professional, organized social-welfare services to play the role in this community that they could play in less conservative communities where their functions are accepted as a valued part of the community life. It is doubtful that these attitudes are unique to rural folk, though our impressions cannot be generalized beyond our study community. It would appear, as Dr. Winston has pointed out, that more and more attention needs to be given to strengthening informal and formal services which can directly or indirectly help older persons maintain themselves happily in their own homes. This calls for a great deal of imaginative use of resources, in rural as well as urban areas. Consideration needs to be given, also, to helping ministers, lawyers, physicians, and others to facilitate the mental health of older persons.

## REFERENCES


1. Britton, J. H., and Mather, W. G. Behavior of older persons as viewed by people in a rural Pennsylvania community. *Amer. Psychologist*, 1956, **11**, 367–368 (abstract).
2. Britton, J. H., and Mather, W. G. Personal and social adjustment of rural older persons. *J. Geront.*, 1957, **12**, 436 (abstract).
3. Lansing, Alice Kendrick. Behavior of older persons as viewed by people in a rural Pennsylvania community. Unpublished Master's thesis, Pennsylvania State University, 1956.
4. *Sixty-five.* A report concerning Pennsylvania's aged by the Joint State Government Commission of Pennsylvania. Harrisburg, Pennsylvania, 1953.
5. U.S. Bureau of the Census. *U.S. census of population: 1950*, Vol. II: Characteristics of the population, U.S. Summary, Chapter C. Washington: U.S. Government Printing Office, 1953.